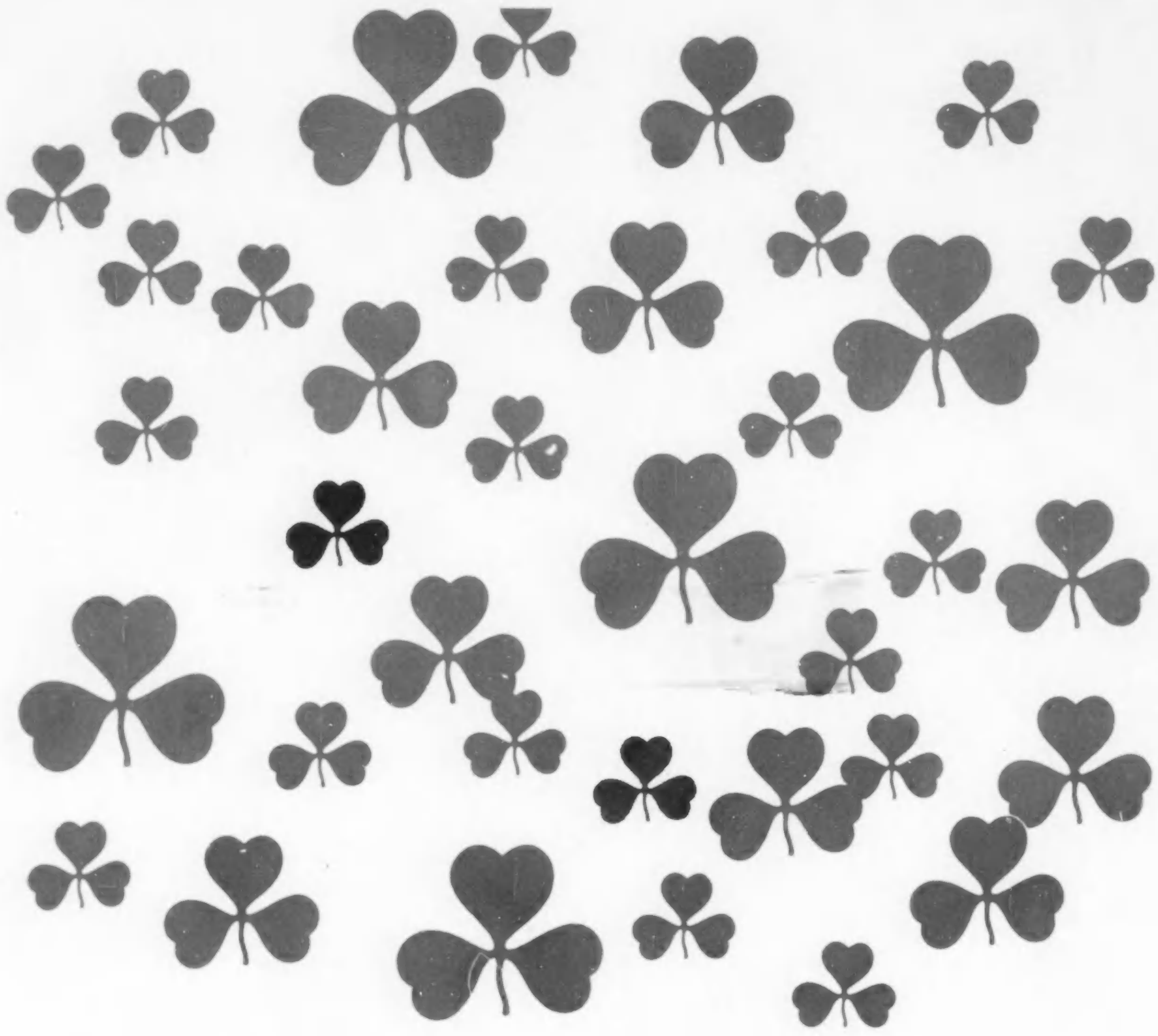
SAE JOURNAL

MARCH
1954

IN THIS ISSUE . . .

PUBLISHED BY THE SOCIETY OF AUTOMOTIVE ENGINEERS



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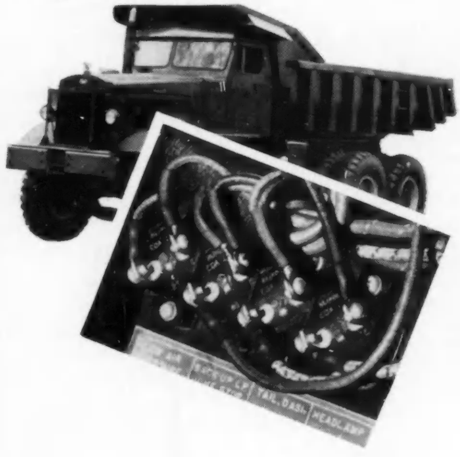

For the Sake of Argument

"WE" . . .

By Norman G. Shidle

"Here's what we might do . . ." probably has sold more ideas than "Here's what this plan will do for you . . ."

The much-touted "YOU" approach may be tops for waffle-iron salesmen. But the "WE" approach may do more for the salesman of ideas, plans, and programs. Where the buyer has to live *in*, not just *with* the product, he doesn't really buy. Rather, he gradually sells himself—and becomes a part of the project. When he does, the sale simply turns out to have been made.

"Here's what we might do . . . ," a young engineer outlined to his boss the other day. He wanted approval of a radical change in departmental routines. By choosing the "WE" approach, he created this climate for his brain-child:

1. Not asked for a "Yes" or "No" decision, the boss couldn't turn the proposal down. He could only refuse to examine it . . . which few supervisors will do.
2. The boss could examine the proposals comfortably, untempted to conclusion-jumping—even in his own mind.
3. The boss' mind was directed right on the proposal . . . not on the young man's proposal. Just on *a* proposal. Person was pretty much out of the way . . . both ways.
4. The boss had a chance to come to a mutual conclusion with the young man to abandon the proposal. The young man was sure to be on the "winning" side, whichever way the decision went.
5. If he liked the proposal, the boss could feel himself one of its parents. . . . He could modify it without seeming to "reform" another's child . . . and he would have a parental interest in its welfare after adoption.

Whatever action might result, the young man stood to gain. He couldn't get turned down, because the approach to analysis had been made mutually with the boss. Only the *plan* could be discarded. And if it were, the young man and the boss together would be discarding it.

The "WE" approach to selling takes the proposer of any idea or plan out of competition. The plan's merits and defects do not attach themselves to its proposer . . . or to its "proposee."

The "WE" approach often has much to recommend it. It's likely to work "down" and "sidewise," too, just as well as "up."

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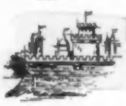

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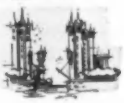

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Business Press, Inc.
10 McGovern Ave.
Lancaster, Pa.

EDITORIAL OFFICE
29 West 39th St.
New York 18, N. Y.
Tel.: LOngacre 5-7174

ADVERTISING OFFICES
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Please address all editorial, advertising, and SAE Special Publications mail to:
29 West 39 Street
New York 18, N. Y.

Contents—March, 1954

Operators in Chicago, Wichita, and San Antonio find

LPG Buses

Offer Low Cost, Clean Exhaust

. . . Harrisburg Railways Co. Differs on Cost

This round-up on experience with liquefied petroleum gas as a fuel for buses is based on three papers presented at the SAE National Fuels and Lubricants Meeting, Chicago, Nov. 5, 1953:

Chicago Transit Authority Reports on Propane
J. N. Jobaris,
Chicago Transit Authority

Three Years of City Bus Opeartion with LPG Fuel
J. E. Ebinger,
Wichita Transportation Corp.

Making Cents with LPG
J. H. Powell,
San Antonio Transit Co.

and discussions by
F. C. Burk,
Atlantic Refining Co.
E. S. Corner,
Standard Oil Development Co.

The papers by Jobaris, Ebinger, and Powell are available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ each paper to members; 60¢ each paper to nonmembers.

SAE Journal printed a series of five articles on LPG as a fuel for passenger cars, trucks, and buses in 1951. Included were articles by Leonard Raymond in June, R. C. Alden and F. E. Selim in July, A. J. St. George in August, M. J. Samuelson in September, and R. S. Lee in November, 1951, SAE Journal.

BUS operators in Chicago, Wichita, and San Antonio find that fueling their fleets with liquefied petroleum gas saves money. Harrisburg, on the other hand, has discontinued LPG buses as uneconomical after comparing 7 LPG buses with diesel and gasoline buses.

The contrasting experiences of these operators offer lessons valuable to others—especially those now considering the economics of switching to LPG in answer to complaints about exhaust smoke and odor.

Cost Differences

Among the four operators, there are marked differences in fuel cost, first cost of equipment, and maintenance expense. For example, liquefied propane or propane-plus-butane costs only about half as much in Chicago as it does in Harrisburg. More to the point, LPG costs at least 5¢ less per gallon than competing fuels in the three cities favoring LPG buses. In Harrisburg, the differential is considerably less favorable to LPG, as Table 1 shows.

Fuel price is of major importance. Fuel costs are the biggest part of direct operating costs, outside of driver salary.

LPG virtually has to be cheaper than gasoline or diesel fuel to compete on the basis of fuel cost. Here's why:

Propane and butane have lower heat content per gallon than gasoline or diesel fuel. But their octane rating is far higher than that of current commercial gasolines. They can stand higher compression ratios than gasoline engines, although LPG engines do not approach the compression ratios used in diesel engines.

The higher octane rating tends to counteract the disadvantage of the lower heat content. But the result is generally that LPG, even in specially designed high-compression-ratio engines, gives some-

Table 1—Comparison of Fuel Costs in Four Cities (Taxes Included)

	Chicago[a]	Wichita[b]	San Antonio[c]	Harrisburg[d]
LPG, ¢ per gal	8.3	11.6	—	16.3
Diesel fuel, ¢ per gal	13.9	—	—	17.6
Gasoline, ¢ per gal	15.2	17.8	—	19.7

[a] Prices prevailing in 1950 when CTA made decision to try LPG.
[b] 1952 prices.
[c] Gasoline is more than 5¢ per gal higher than propane.
[d] Prices varied during test period. Prices shown are averages weighted accordingly.

what less mileage per gallon than the other two fuels. Where this is so, LPG has to be cheaper per gallon to give the same fuel cost per mile.

Bus prices and maintenance experience are among the other reasons why three operators find LPG economical and a fourth didn't. Chicago paid $3000 less per bus for 500 LPG buses bought in 1950 than it would have for diesel buses. Harrisburg, when it shopped for new buses, paid only $375 less for LPG buses than for diesels.

LPG can be expected to reduce bus maintenance. The reason is that LPG enters the combustion chamber as a gas, not as a liquid. It doesn't wash the lubricating oil off the cylinders and leave them exposed to rapid wear. Neither does it leave carbon deposits. Chicago, Wichita and San Antonio found that LPG did reduce maintenance. Harrisburg, on the contrary, found that its LPG buses cost more to maintain than the more familiar equipment.

While these four operators made their choices of equipment largely on the basis of cost, Chicago favored LPG for its probable availability in wartime also. Come a war, millions of civilian and military vehicles will be competing for gasoline. And jets may monopolize the middle distillates, leaving little for diesels. But the supply of LPG, which is a byproduct of both oil well and refinery operations, is likely to exceed demand in wartime as it does now, the Chicago Transit Authority figured.

Clean Exhaust

The biggest advantage—other than lowered costs—that Chicago, Wichita, and San Antonio noted is the one that is causing bus operators all over the country to look on LPG with renewed interest: LPG burns so completely that its exhaust has no noticeable smoke or odor. (Harrisburg noted the effect, too, but the company has not been troubled with complaints about exhaust from either gasoline or diesel fuel systems.)

LPG buses are quiet, too. They are no noisier than gasoline buses—much quieter than diesel buses.

What to Check

The experiences of these four companies plus fuel marketing studies indicate that prospective operators of LPG buses should check:

1. The availability of suitable LPG equipment at prices competitive with diesel or gasoline buses.

2. The likelihood that the fuel price structure will be sufficiently favorable to LPG.

A prospective operator should decide on his seating capacity and power requirements. Then he should shop around among bus manufacturers. He may find that he can get an especially low price on an LPG fleet because a manufacturer is eager to have a new design in use. Or he may find he must pay a premium—because LPG buses are not available in as many sizes as other types are, he may have to pay for more space and power in an LPG bus than he needs.

Operators can secure data on LPG prices from major oil companies and from distributors handling LPG for cooking and for fueling farm equipment. Since LPG is not an abundant byproduct of refinery processing, its price at this source may be high; on the other hand LPG is abundant in most oil-producing areas, where its price is relatively low. But LPG is relatively expensive to transport. The farther the customer is from major LPG sources, the more LPG costs him.

A little LPG is available in the Northeast from refinery operations, but it's high priced. And if demand increased, LPG would have to be brought in by tank cars or pipe lines. Therefore, LPG is generally not competitive with diesel fuel in the Northeast. Nor is the picture likely to change. Studies show that pipelines hold little or no promise for low-cost propane availability in that part of the country.

Not to be overlooked, even in areas where LPG is cheap, are the costs of storing and handling LPG. Some fuel suppliers will provide the storage and handling equipment at a customer's garage if the account is large enough. A small operator may be able to arrange with the local LPG distributor to fuel his buses.

Either way, LPG requires an investment in elaborate tanks, pumps, lines, and fire-safety devices stipulated by government and insurance regulations. (But safety records have been so good that insurance rates are generally no higher than for other bus fuels.)

Whether or not fuel savings will justify the investment is largely a matter of miles operated per year. The more miles, the more likely that LPG equipment will pay. (Further information on the relation of mileage to LPG economics is available in the paper "Relative Economics of LPG, Gasoline, and Diesel Fuel in Trucks and Buses" by E. S. Corner and E. H. Berg in American Petroleum Institute Proceedings, Vol. 31M, Section 3, pp. 223–272.)

For those who want more facts on LPG operations, details on the experiences of Chicago, Wichita, San Antonio, and Harrisburg appear on the following pages.

Chicago

—J. N. Jobaris, Chicago Transit Authority

Fuel Costs—A survey made several months ago showed that on fuel we spent $37.84 per 1000 miles for our LPG buses and $43.10 for our diesel buses.

Low fuel costs were a prime factor in our decision to buy LPG buses. Propane cost 8.3¢, diesel fuel 13.9¢ and gasoline 15.24¢ per gal in 1950 at the time we chose LPG over diesel buses for our new fleet. Also, it was possible to obtain a fuel contract assuring that the propane price would remain at least that much below the diesel price for five years.

We get about 80% as much mileage per gallon of propane as per gallon of diesel fuel.

Buses—We operate 500 Twin Coach and 51 ACF propane-fueled buses acquired in 1950–1951. Fifty million miles of operation on these led us to order 400 more LPG buses, which began arriving last August.

The Twin Coach's Fageol engines have a 451-cu in. displacement and a 200-hp rating at 2400 rpm with a 10 to 1 compression ratio. The ACF engines have a 707-cu in. displacement and a 210-hp rating at 2200 rpm with a 9.2 to 1 compression ratio.

The bid which resulted in purchase of the 500 Twin Coach buses offered them at approximately $3000 less per bus than diesel-fueled buses.

All our buses have 105-gal Parkhill-Wade tanks. A small outage tank inside the main tank takes care of fuel expansion. Inserting the filler nozzle closes the valve to the outage tank. Fuel is pumped into the main tank at approximately 30 gal per min until refusal. Removing the filler nozzle automatically opens the valve to the outage tank.

Refueling LPG buses actually presents less difficulty than refueling gasoline or diesel buses, we find.

Fueling Equipment—Our LPG storage tanks are all above ground. The North Park garage installation has four 18,000 gal (water capacity) tanks. The North Avenue and 77th Street garages each have two 18,000 gal tanks, and the 69th Street garage has one.

Each station has two five-stage multivane turbines for unloading supply trucks and pumping fuel into buses. This way, we can unload and fuel at the same time. And if one pump fails, we can still operate.

Tips on LPG Operations—Here are some precautions we take:

- Put anhydrous alcohol into the tank with the first fuel charge of a new bus. This takes care of any water that may have condensed in the tanks. Otherwise the water may freeze in the fuel lines, filters, or regulators of brand new buses.
- Write your company specifications for LPG around those of the Natural Gasoline Association of America. CTA follows NGAA's advice and limits sulfur content to 15 grains per 100 cu ft of gas. Actually, fuel delivered to us contains less than 10 grains of sulfur per 100 cu ft of gas. The supplier tests each run of gas for sulfur. Besides, we take samples from each of our garages four times a month and send them to an independent testing laboratory for sulfur measurement.

As the NGAA specifications require, the odorizing agent added to the LPG must be completely stable.

- Use a fail-safe solenoid or a vacuum-type fuel line valve to shut off fuel at the tank automatically when the ignition is turned off. This has contributed greatly to our record of 18 months without a fire on propane buses. In the few earlier instances of fire, we found that the fire died out almost immediately when the driver turned off the ignition switch.
- See that regulators incorporate sturdy valves. Permit no soft-soldered joints on the fittings or connections in the regulator-vaporizer unit.
- Use the U-69 250 lb working pressure fuel tank with a relief valve setting of 312 lb. (U-69 is part of the 1949 Unfired Presure Vessel Code available through the American Society of Mechanical Engineers.) Use the high-quality valves and gages approved by Underwriters Laboratories for use with LPG.

Wichita

—J. E. Ebinger, Wichita Transportation Corp.

Fuel Costs—Fuel costs for our 91 propane buses averaged $33.66 per 1000 miles in 1952. Fuel costs for 60 gasoline buses in 1949 averaged $42.37 per 1000 miles. (We paid 11.58¢ per gal for propane and 17.78¢ per gal for gasoline in 1952. In 1949, gasoline cost us 16.6¢.) Table 2 compares data for the two years.

This comparison is a little hard on propane. Because our fleet has grown, we store some of our propane buses outdoors and during cold weather we idle them to keep them warm. This consumes fuel without producing mileage. Also, in 1949 all our buses ran all day. In 1952, after we had enlarged our fleet, some of our buses, including some

Table 2—Comparison of Wichita's Costs with Gasoline in 1949 and Propane in 1952

Year	Fuel Used	Buses	Mileage Operated	Gallons Fuel Consumed	Miles Per Gallon	Oil Consumed Including Oil Changes, Gal	Miles Per Gallon Including Changes	Fuel Cost Per Mile
1949	Gasoline	60	3,128,818	826,020	3.79	9679	323	$0.04237
1952	Propane	90	4,296,321	1,249,566	3.44	6224	690	$0.03366

propane buses, operated only during rush hours. Naturally, traffic congestion boosts fuel consumption averages for these buses.

We feel that if we could compensate for these differences—plus the increase in traffic since 1949—propane would give at least 97% as much mileage per gallon as gasoline.

Buses—Our propane-fueled buses range from 34 to 40 passenger capacity. All are equipped with FTC-180 Fageol engines converted for propane. Our other 30 buses burn gasoline. We have no diesel buses.

Maintenance Experience—Although the first two propane buses we acquired operated over 230,000 miles in 3½ years, no engine parts were replaced except spark plugs, ignition points, filter socks, and bellows and seats of the propane regulator.

At the 230,000 mile mark, these two buses were consuming 1 gal of add oil every 700 miles. Fuel consumption was 3.74 miles per gal, which is 0.3 mile per gal more than our 1952 fleet average. Wear measurements taken on one of these engines proved it was in just as good condition as fuel and oil consumption figures indicate:

Cylinder wall wear measured 1½ in. from the top was 0.005 in. maximum.

Cam shaft wear was under 0.001 in.

Valve stems showed no measurable wear. Seats were in perfect shape.

Crankshaft main bearings were standard size. Connecting rod bearings were 0.001 in. undersize.

These two buses aren't exceptional among our fleet. We have more than 40 other buses close to the 200,000-mile mark that also have required no replacements except those mentioned for the two 230,000 mile buses. We expect that our propane buses will run 400,000 miles before they need rebuilding. Maybe more.

We change crankcase oil and filter socks every 14,500 miles. The oil stays clean, but because there's no fuel dilution, oil viscosity increases. Also the oil tends to absorb sulfur, which in the form of sulfuric acid is corrosive to bearings.

Tips on LPG Operations—During the winter, we use 100% propane. In summer we use a 70% propane, 30% butane mixture. This reduces tank pressure on hot summer days. We do not pay a premium price for the propane-butane mix.

We save the expense of heaters for buses stored outdoors in cold weather by idling our LPG buses. They, unlike gasoline or diesel engines, can be idled for hours without harm.

San Antonio

—**J. H. Powell,** San Antonio Transit Co.

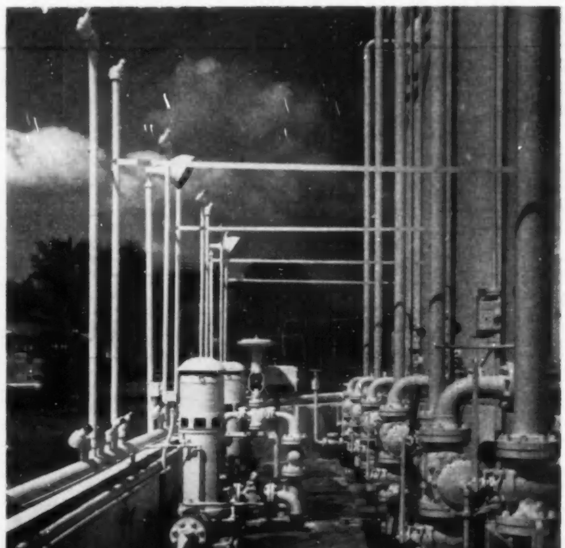
Fuel Costs—Propane for our operation is a little more than 5¢ cheaper per gallon than gasoline. (A very rough rule of thumb is that propane must be 5¢ per gallon cheaper than gasoline to warrant conversion.)

Although we get between 10 and 25% less mileage per gallon on LPG than on gasoline, the lower cost of LPG more than offsets the loss. We save 1 to 1½¢ per mile by using LPG.

If the average saving is taken as 1¼¢ per mile, the gross saving is $225,000 on the 18 million miles

TANKS AND FOG SYSTEM

San Antonio's six propane tanks stand in the parking lot. A water fog system protects against fire. The water is supplied by the pipe running just above the retaining wall to the waist-high nozzles and to the vertical pipes leading to the higher nozzles



our LPG buses have run since January 1951. This leaves us a tidy profit on fuel savings alone—even though we paid $85,000 for our dispensing facilities and around $110,000 extra for LPG equipment on buses. Savings on maintenance are an added bonus.

Buses—Our first purchase of propane buses consisted of 15 33-passenger Marmon Herringtons and 15 45-passenger Twin Coaches in January 1951. The Marmon Herringtons have 104-hp Ford engines of 7.86:1 compression ratio and Century regulators and carburetors. The Twin Coaches have six-cylinder, 404-cu in., 180-hp, 10:1 compression ratio engines. Parkhill-Wade fuel tanks and Ensign carburetors complete the LPG installation.

In these Twin Coaches, liquid propane flows under its own pressure from the bus tank through two ignition-controlled solenoid valves to the regulator. Here the pressure is reduced in two stages from 100–200 psi to slightly less than atmospheric. Warm water from the engine circulates around the regulator to aid vaporization. Vapor goes from the regulator to the carburetor. From there on, it is treated like gasoline vapor.

Similar Ensign and Parkhill-Wade equipment was used in 62 45-passenger Twins bought in 1948 and converted in 1951 from gasoline to propane. Compression ratio was raised from 7.3:1 to 10:1.

In the spring of 1952, we converted 50 32-passenger ACF Brills to propane. Air conditioning equipment filled the space in these buses that would otherwise have been available for enlarged fuel tanks. No other space was available for the usual 100-gal round tank. So we ordered flat-bottom, flat-top tanks of elliptical cross-section. Stay bolts welded to the top and bottom provide strength. The small outage tank is outside the main tank, unlike the other Parkhill-Wade tanks.

The one difficulty with our converted ACF Brills is that heat from the engine and from the road surface warm the tank. This makes it hard to fuel these buses.

Later in 1952 we bought 30 additional 45-passenger Twin Coaches, bringing the total to 172 propane buses.

Although our 172 propane buses comprise only 57% of our fleet, we operate 80% of our mileage on propane for economy reasons.

Fueling Arrangements—Our storage and dispensing facilities consist of six 5000 gal (water capacity) vertical tanks mounted above ground in a row. One of two 10-hp, four-stage centrifugal Pacific pumps transfers liquid propane from the tanks to a 4-in. line leading 125 ft to the service station. The other pump is a stand-by. When the buses are not taking the full pump output, a Taylor differential controller bypasses the excess back into the tanks.

The 4-in. line from pumps to service station is encased for safety in a 6-in. line. Should a break occur in the 4-in. line or at the pump, the operator could close off the tanks by means of air-operated Fisher valves which are controlled from a remote location. Pump electrical controls are also remotely controlled.

At the service station the 4-in. line goes overhead to form a header from which 2-in. lines lead to five Parkhill-Wade dispensers. Return vapor lines lead from the dispensers back to the tank.

Our unloading dock is adjacent to the tanks. The delivery truck parks on a concrete curbed apron. A Corken liquid pump draws the liquid from the delivery truck tank and forces it into the storage tanks.

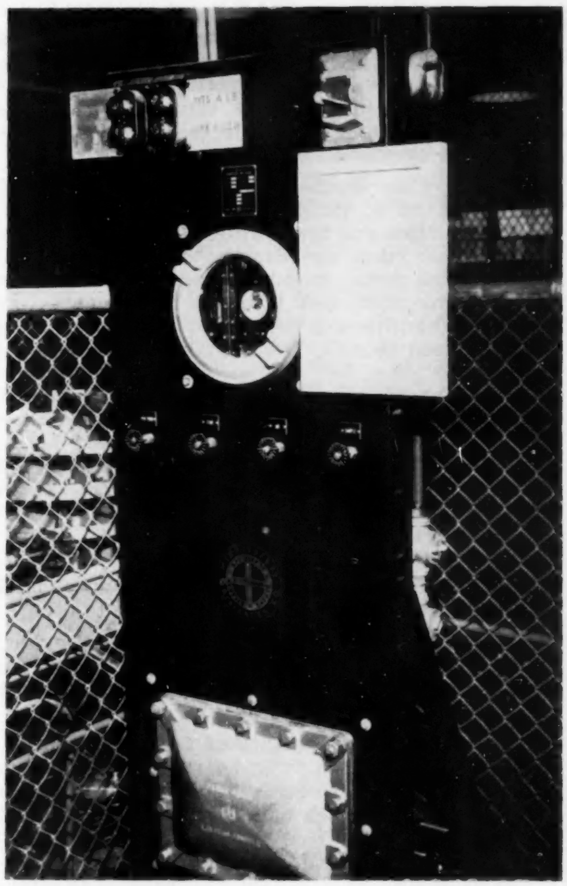
In case of power failure, a portable gasoline-engine driven pump can either unload a delivery truck tank or fuel the buses.

Some of the many safety devices we have installed for handling LPG are:

1. Excess flow valves at all outlets of all storage tanks. These spring-loaded valves would cut off the flow in case of a break in the lines.

2. Pressure release valves on top of each tank. These are of the triple-valve type. When one valve is removed for testing, the other two can handle the tank and cannot be shut off. Also, pressure release valves are installed in each section of the lines which can be closed off by valves.

3. Pressure-sensing devices atop each storage



FLAMMABLE GAS DETECTOR

This "sniffer" samples the atmosphere at four remote locations and gives warning as soon as it detects flammable gas at any of them

tank. When tank pressure reaches 210 psi, cooling water sprays over the tank. This is to prevent these tanks from reaching the 250 psi pressure at which relief valves operate.

4. Three 1000-gpm water fog systems. One system, manually but remotely controlled, is at the tanks. A second takes care of the unloading dock. The third discharges from the floor and ceiling of the service station. When a gasoline bus caught fire at the service station, the fog system there snuffed out the flames in seconds. (We've never had a propane fire.)

5. A static electricity collector which drags grounded cables across a bare metal spot on the roof of each bus as it enters the service station.

6. Flammable gas detector. This mine safety device sucks in a sample of the atmosphere at four locations (service station, unloading dock, pipe trench, and tanks) once each minute. The detector analyzes the gas samples automatically. If a sample is flammable, the detector sets off both audible and visual alarms.

7. Propane flare. A flare with flame arrester and continuous pilot disposes of the 4 gal or so of fuel left in the 32 ft of 2-in. hose leading from delivery truck tank to storage tank.

Maintenance experience—It's apparent that our converted Twin Coaches are going to give us 300,000–350,000 miles before overhaul. They had reached 120,000 miles before conversion, and on gasoline could have gone only to 175,000 miles at best before overhaul.

We believe an engine run only on propane may well go 400,000 or 450,000 miles before overhaul.

Our LPG buses run 24,000 miles between oil drains. Our gasoline buses are drained every 6000 miles. Although the saving in oil cost alone is small, the reduction in labor cost when oil is changed less frequently definitely is important. LPG buses do, however, need about as much make-up oil as gasoline buses.

One of the maintenance difficulties we have not yet solved is rapid wearing of intake valves on one type propane engine. Nor do we know why it occurs to the greatest extent on No. 3 and No. 4 valves. (On LPG buses, we set valve clearances every 12,000 miles—twice as frequently as with gasoline engines.)

Tips on LPG Operations—From our experiences with LPG, we can pass along this advice to others:

- Be sure you check your plans with all the necessary regulatory bodies. For example, before we could install storage facilities and convert our first bus, we had to obtain approvals from:

  Fire Marshal of the City of San Antonio
  City Council of the City of San Antonio
  Texas Bureau of Fire Prevention and Engineering (which called in the U. S. Bureau of Mines)
  National Bureau of Fire Underwriters Laboratories
  Texas Insurance Commission
  Railroad Commission of Texas

Procurement of approvals took almost a year. But the various bodies rendered a wealth of very valuable advice.

- Lay your pipes in an open trench, and don't fasten them or pass them through the concrete foundations of above-ground tanks. Then if the foundation shifts, the pipe is most unlikely to shear or to wrench away from a tank.

- Don't insist on paying for propane according to your receiving meter. Propane gallonage depends on its temperature and pressure conditions, which are sure to vary at your meter. When we negotiated our propane contract, we told our supplier in a nice way that we were going to check his delivery-truck measurements and that we would pay only for the quantity registered by our receiving meter. The supplier insisted that we use his measurements.

We finally gave in. But we assured the supplier that we would certainly put up an argument if the readings didn't agree.

Our first load of propane was delivered in a 4500-gal transporter. When it had run through our meter, the meter read 6000 gal. Needless to say, we did not insist on paying according to our meter after that.

- Install a micro switch on the door to the bus fuel compartment and wire the starter circuit through it. Then no one can start the bus and drive away with the filling hose still connected.

Before we did this, our hostlers accidentally moved buses before disconnecting the hose. Hoses broke, releasing several gallons of propane each time before the excess flow valve snapped shut.

- Flushing regulators with paint solvent every 12,000 miles will remove any gum formed. Gum accumulates from pipe compound, scale, welding flux, and other materials used in construction and repair of storage and bus tanks and lines.

- Arrange a short course on propane properties and fire-fighting methods for new employees who are to handle propane equipment. Give everyone a refresher every few years.

- Standardizing spark advance and setting the carburetor according to exhaust gas analysis alone gives best results.

We used to use a dynamometer too. Then the mechanic varied both spark advance and carburetor setting to get the best compromise between maximum horsepower as indicated on the dynamometer and best economy as indicated by the exhaust gas analyzer.

Rather than have the mechanic juggle two variables, we now have him set spark setting at 10 deg BTDC. Then, using the torque converter as load and with the engine at 1500 rpm, the mechanic adjusts the carburetor to a 15.4:1 air/fuel ratio reading on the exhaust gas analyzer. This setting provides very good fuel economy and, at the same time, enough power for our operation.

If engine speed falls below 1450 rpm when the carburetor is set to 15.4:1, malfunction is indicated. The mechanic may then have to resort to the dynamometer to diagnose the trouble.

We reset carburetors of both propane and gasoline engines every 6000 miles.

- Don't overlook the lower fees incurred by less expensive LPG buses when comparing them with

diesel buses. Our LPG buses cost about $2000 less apiece than diesels. Because of this difference, we save more than $400 per year on ad valorem taxes, license fees, insurance premiums, and other fixed costs on each LPG bus.

Harrisburg

—**F. C. Burk**, Atlantic Refining Co.

Fuel Costs—Over the two years that Harrisburg Railways Co. was comparing LPG, diesel, and gasoline equipment on its routes, fuel costs averaged $48.50 per 1000 miles on LPG, $31.50 per 1000 miles on diesel fuel, and $49.00 per 1000 miles on gasoline.

Average mileage per gallon was 3.36 for new Twin Coach LPG buses, 2.52 for buses converted to LPG, 5.59 for diesel buses, and 4.02 for gasoline buses.

Buses—Harrisburg didn't set out to prove one fuel was better than another. The aim was to find out which of the buses available was best for their operation.

To this end, the company bought five new LPG buses, converted two gasoline-fueled buses to LPG, and bought 10 new diesel and 5 gasoline buses. The new buses were of the latest design on the market. Both new and converted vehicles went into operation during the winter of 1950–1951.

The five new LPG-powered buses were Twin Coach 37-passenger vehicles, Model 38S. The engine was Model 180-17. Its displacement was 404 cu in., compression ratio was 9.65:1, and brake horsepower was 198.

The two engines converted from gasoline to LPG were Hall-Scott Model 136's in ACF Brill buses. Displacement was 477 cu in. and after conversion the compression ratio was 8.95:1.

The 10 diesel buses were new General Motors Model 471, 36-passenger units powered by the GM four-cylinder two-cycle engine. Displacement was 284 cu in., compression ratio was 17.1:1, and brake horsepower was 133 at 2000 rpm. The engines were mounted in the rear. The power train included a remotely controlled V-drive fluid clutch.

The five new gasoline-powered buses were Twin Coach Model 38S 37-passenger vehicles. The engine was Model 180-1. Displacement was 404 cu in., compression ratio was 7.3:1, and brake horsepower was 180 at 2800 rpm.

Table 3—Harrisburg's Costs for 200,000 Miles of Bus Operation

Vehicle Type	Fuel	Oil	Maintenance	Engine Overhaul	Total
LPG	$9700	$100	$5400	$400	$15,600
Diesel	6300	190	4000	900	11,390
Gasoline	9800	120	4400	600	14,920

In round numbers, prices were $15,375 for the LPG bus, $15,750 for the diesel bus, and $15,000 for the gasoline bus. Harrisburg wasn't lucky enough to get a special low price on LPG equipment. In fact, it was necessary to buy somewhat more powerful LPG engines than were actually required.

As has been reported in a paper ("Comparison of LPG, Gasoline, and Diesel Fuels in City-Bus Operation" by F. C. Burk, E. S. Black, and L. J. Test, Atlantic Refining Co. presented before the American Petroleum Institute in New York on May 14, 1953), all buses on test were operated on the regular schedules. Buses changed from route to route, so that all covered the same courses. Drivers rotated from bus to bus.

Drivers rated diesel buses first for their good performance at low speeds. LPG buses come in second, superior to gasoline in smoothness and power. Starting was no problem because all buses were stored in a heated garage.

All new test vehicles were operated approximately 80,000 miles during the course of the comparison. Mileage covered by the LPG conversion units was lower because one developed serious mechanical difficulties and the other was damaged in an accident.

The original plan was to operate the engines until they needed overhaul. But the test was terminated after two years because the economic advantage of the diesel bus over the LPG and gasoline buses was already apparent.

Fueling Arrangements—Storage and dispensing facilities for diesel fuel and gasoline were already in place. Installation of a 15,000-gal (water capacity) tank and associated equipment for LPG cost $12,250. This equipment was not furnished by the fuel supplier, as is the custom with gasoline and diesel equipment.

If use of LPG had been continued, it would probably have necessitated more investment. Insurance companies were pressing for installation of high-capacity ventilating fans and ducts in the shop areas.

Maintenance Experience—At Harrisburg, maintenance costs were higher for the LPG equipment than for the diesel and gasoline buses. Average costs per thousand miles were $76.00 for LPG, $52.45 for diesel, and $71.60 for gasoline buses.

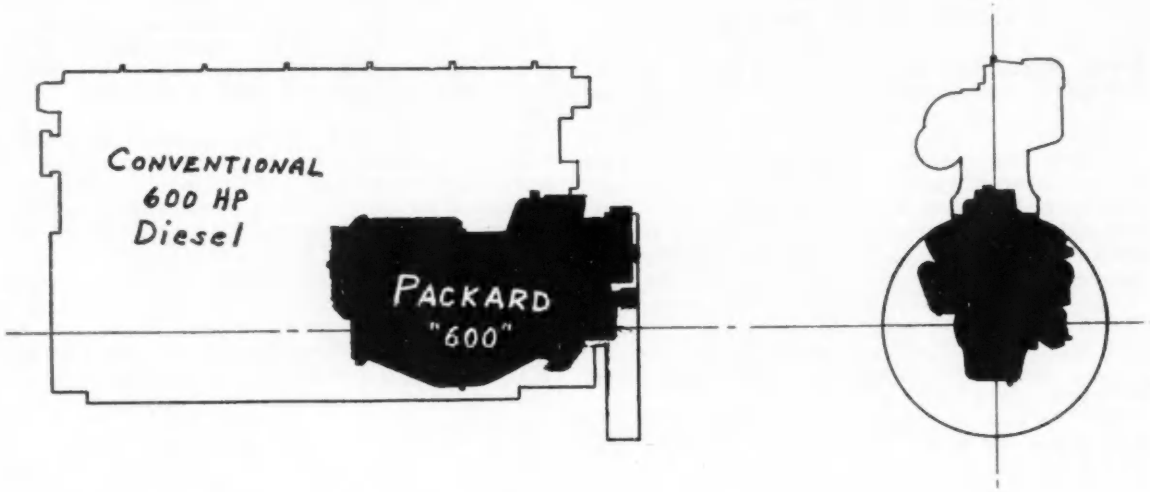
Oil economy was best with LPG equipment. LPG buses averaged 250 miles per qt, diesels averaged 132 miles per qt, and gasoline vehicles averaged 188 miles per qt. Oil was changed in LPG and gasoline vehicles every 6000 miles. Diesel buses started out on a 3000-mile period but were switched to the 6000-mile basis in the course of the test.

To estimate total costs, overhaul mileage and expense were estimated. Overhaul of LPG engines was assumed to cost $400 and take place at the 200,000 mile point, overhaul of diesels at $450 and 100,000 miles, and overhaul of gasoline engines at $400 and 150,000 miles.

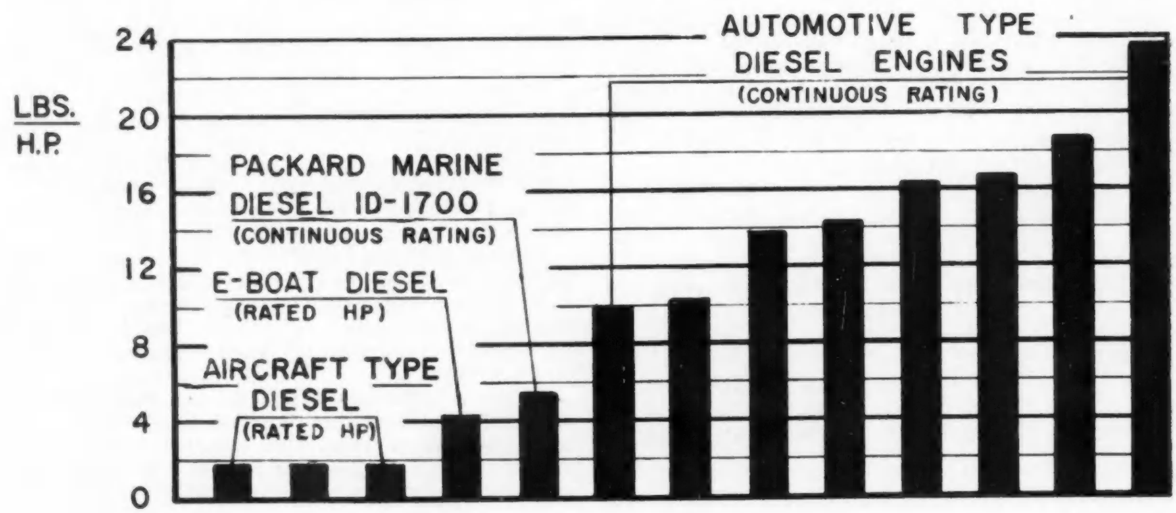
Overhaul costs plus fuel, oil, and maintenance costs are totaled in Table 3. The figures show LPG buses cost about $840 more per year than diesel buses. LPG and gasoline figures are close, but gasoline is a little more economical on this basis.

Packard's Lightweight Diesel Packs

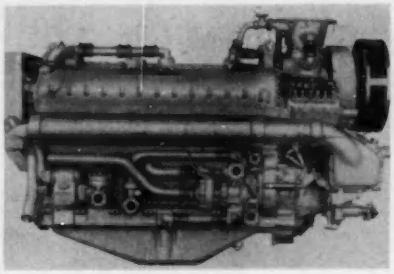
Small . . .



. . . But Powerful Physique



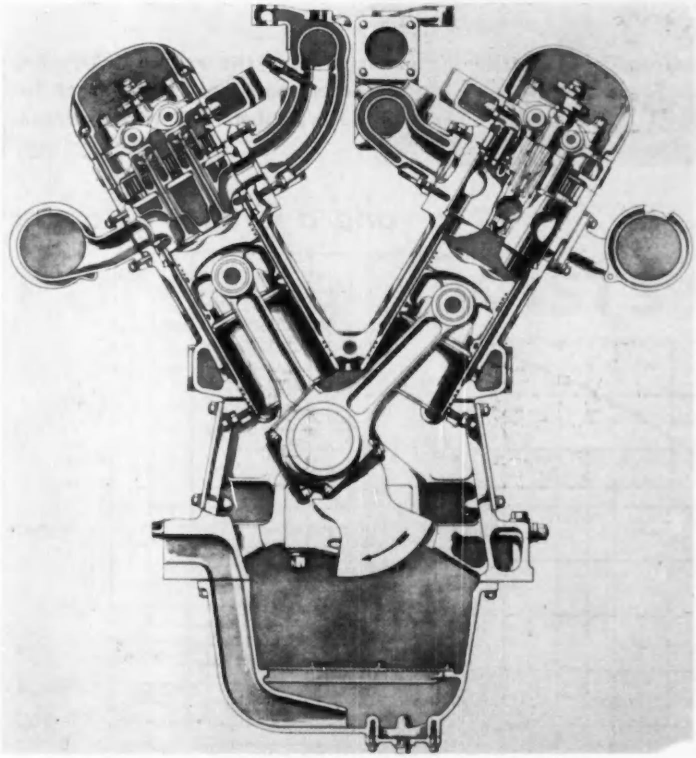
Heavyweight Punch



M. Ware, R. E. Taylor, and J. Witzky, Packard Motor Car Co.

Based on paper "The New Packard Lightweight Diesel Engines" presented at SAE National Diesel Engine Meeting, Chicago, Nov. 4, 1953. Complete paper will appear in 1954 SAE Transactions. It can also be obtained from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.

Equally Good Right and Left



EACH BANK of 6 cylinders in Packard's new V-12 diesel produces 300 hp at 2000 rpm. Bore of 5⅜ in. and stroke of 6¼ in. give each cylinder 142 cu in. displacement at 15 to 1 compression ratio. Fuel is injected directly into precombustion chambers. There are four overhead valves per cylinder. Thanks to extensive use of aluminum, the engine tips the scales at only 3300 lb.

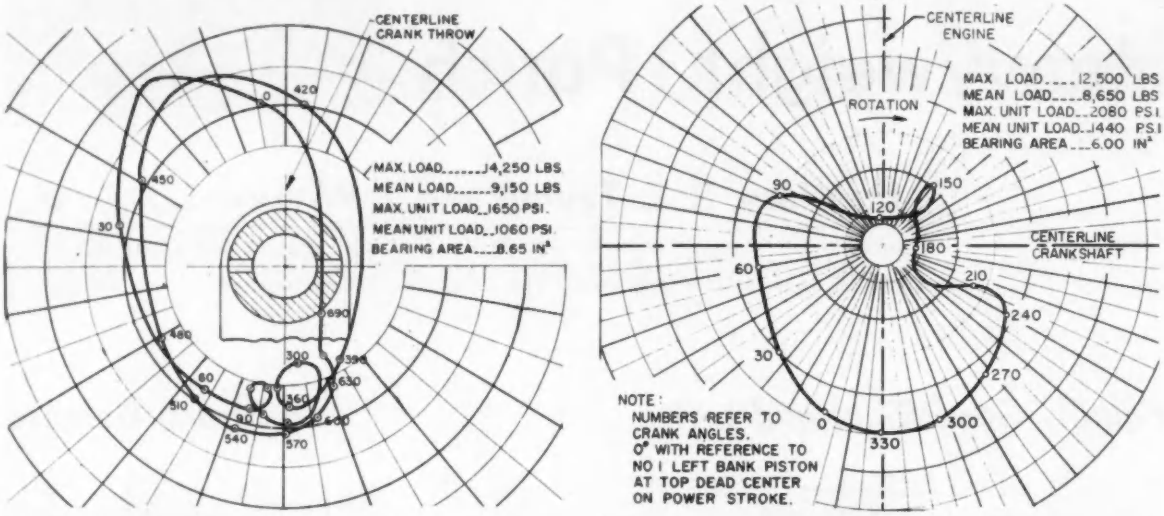
. . . a Strong Defense

ONE-PIECE cylinder and head assemblies eliminate high-pressure gasket trouble. To extend life, valve-seating surfaces on cylinder heads and valves are stellited; cylinder walls nitrided.

Please turn page

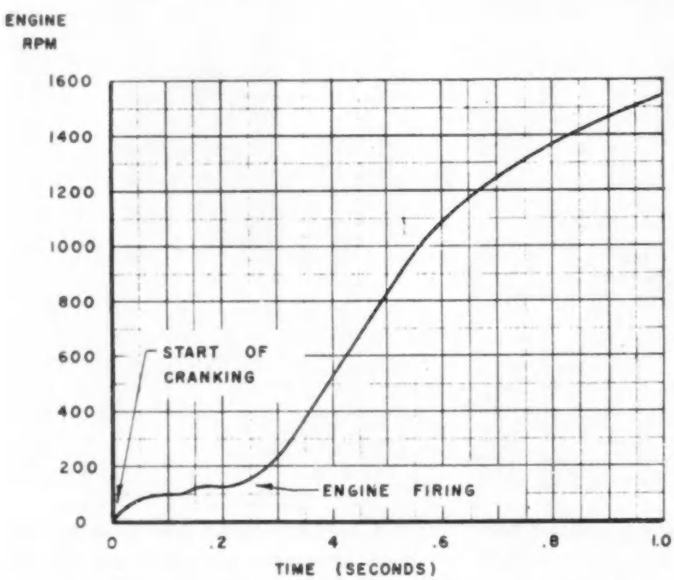
Packard Lightweight Diesel — Continued

Legs That Can More Than "Go the Distance"



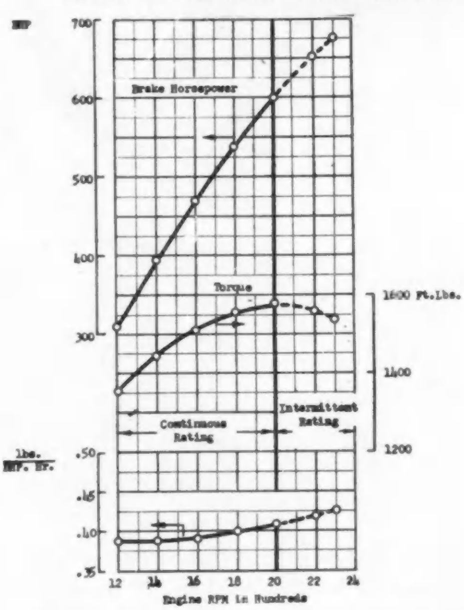
BEARING CAPACITY of the new V-12 was not sacrificed in the effort to keep the engine light. Evidence of this is shown above. Pictured are the crankpin journal and center main bearing loads at full engine output: 600 hp at 2000 rpm. (Scale: 1 in. = 5000 lb) The engine has a substantial nitrided crankshaft with 4 in. journals and 3⅝ in. crankpins. Cheeks are 1 in. thick.

A Fast Starter . . .



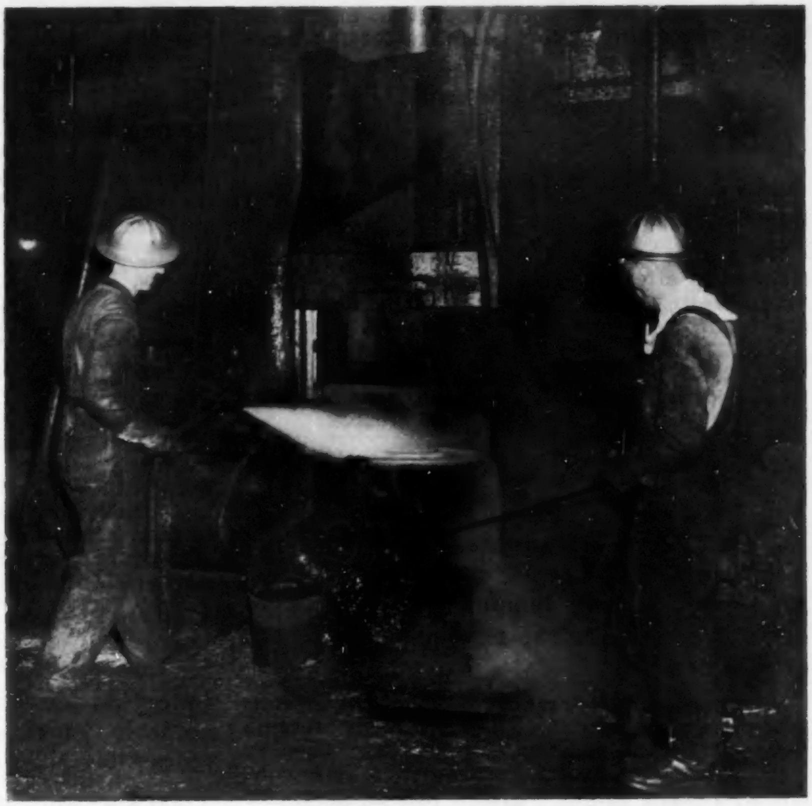
PROMPT STARTING and rapid acceleration of this 12-cyl diesel are possible at normal room temperatures. Starting can be accomplished with either compressed air or an electric motor.

and a Great Performer



AT 2000 RPM, this V-12 delivers 600 hp and 1580 ft-lb of torque. Specific fuel consumption is just over 0.4 lb per bhp-hr.

Drop Forging like this is real old stuff especially compared to today's



Forging Twists and Tricks

H. Winkleman, Ladish Co.

Based on secretary's report of Panel on Forging held as part of the 1953 SAE Tractor Production Forum, Milwaukee, Sept. 14, 1953.

What's New: Germans hammer out finished gears. . . Artillery shells get 16 hot and cold squeezes. . . U. S. forgers become more enamored of counter blow hammers.

In Germany, gears for automobile and tractor differentials are being completed on forging hammers. The teeth machining operation has been eliminated entirely. To Europeans, metal—not machining and labor time—saved in such precision forging of gears is the important gain.

Here in this country, 16 hot and cold squeezings are being used to produce 105 and 155 mm artillery shells. First comes a press operation performed on hot metal. This is followed by two "hot" extrudings; then 13 "cold" drawing operations complete the job. With this method, 200 shells can be produced in an hour.

Counter blow hammers—quite common in Europe—are spreading their wings in the U.S. To the family of light hammers long used in cutlery manufacture are being added many big brothers—units that can pound out 8500 lb. forgings. With these counter blow hammers, all shock and vibration is absorbed in the dies and the machine. (Foundations are as deep as the hammers are high.) Such

special equipment as floor manipulators are much-needed "Men Friday" to these giant forging hammers.

Anvil Breakage: How to put the hex on it.

Don't drive sow (anvil cap) block keys too tight. Doing this often causes anvil cracking. If automatic key drivers are to be used, it's important that their driving power be controlled. Still another deterrent to anvil breakage is properly tapered keys. Keys that fit tight at the large end (or tight at the small end and loose at the large end) tend to loosen up during use . . . and this spells trouble.

To Meet Those Tolerances: Keep billet weights the same, carefully control forging temperatures, don't overestimate the powers of man or machine.

Whether forging tolerances are to be met depends largely on these four things—billet weight, forging temperature, the machine, and the man using it.

It's extremely important to maintain close control over billet weight. With a forging press, for example, an underweight billet will not supply enough metal to fill the die cavity. "Heavy" stock, on the other hand, will result in an oversize forging.

Constant temperatures are also a must for accurate thickness control with both drop hammer and press forging. For example, large hammer-forged connecting rods will suffer severe shrinkage variation if temperature is not controlled.

Finally, there's a limit to the ability of a particular forging unit or a particular operator. In the case of the machine, it's important not to set up forging tolerances which it can't possibly meet. As for the man, capability of individuals must be taken into account.

The Men in the Know . . .

. . . who gave this account on what's new in today's forge shop were:

C. E. Stone, Panel Leader
Interstate Drop Forge Co.

H. Winkleman, Panel Secretary
Ladish Co.

J. Dierbeck
International Harvester Co.

C. Olson
Unit Drop Forge Division
Fuller Manufacturing Co.

H. Tillson
Ladish Co.

H. F. Wood
Wyman-Gordon Co.

Resink Dies Prematurely: Key to a steady stream of quality crankshafts.

The secret to consistent production of high quality crankshafts is to resink dies before they are worn out. While this naturally cuts die life, more high quality forgings are ample compensation. This method is best applied when two hammers are used to produce a crankshaft, that is, a breakdown or blocker die and a finishing die.

Induction heating of billets sows no scale, boosting die life; but it costs more than oil heating.

Dies may well last 25 to 100% longer when billets are induction heated rather than oil heated. That's because induction heating doesn't promote scale formation on billets (oil heating does)—instead it tends to remove scale already there. Thus scale packs are not created in the dies. What's more, since induction heating heats stock at a constant controlled temperature, there's no chance of cold forging taking place (as is possible with high production oil heating). Induction heating is, however, considerably more expensive than oil heating except in certain applications.

Quality control charts spark competition.

Statistical quality control can be used to good advantage in a forge shop. By picturing in simple graphs such things as dimensional control and die life obtained by individual workers, competition can be built up. Trouble jobs, too, can be surveyed on a statistical basis, with resulting graphs used to pinpoint the source of a problem.

(The report on which this article is based is available in full in multilithographed form together with reports of the six other panel sessions held at the 1953 SAE Tractor Production Forum. This publication, SP-303, can be obtained from SAE Special Publications Department. Price: $1.50 to members, $3 to nonmembers.)

Exhaust-Valve Deposits—

How They Can Be Reduced

A. R. Schrader, USN Engineering Experiment Station

Based on secretary's report on Round Table on Diesel Exhaust-Valve Problems Associated with Fuels and Lubricants held at SAE Summer Meeting, Atlantic City, June 11, 1953.

ENGINE exhaust-valve problems associated with fuels and lubricants are usually problems of deposit formation. Deposits on valve stems or guides may cause sluggish operation, valve sticking, or faulty seating. Deposits on valve faces or seats may cause poor seating, guttering, and burning of the valves or seats. Exhaust valves have some ability to clear themselves of deposits, but if the deposits form faster than they can be removed, valve operational troubles may result.

Valve deposits originating from the fuel oil are generally carbonaceous in nature. (See Fig. 1.) They form on the entire exposed lower end of the valve and in some cases in the valve ports and some areas of the exhaust manifold.

Valve deposits caused by fuel oil are formed during light-load engine operation when cylinder temperatures are too low for the complete vaporization and burning of the fuel. The condition is aggravated by low intake air temperatures. The deposits are usually burned off if the engine is operated subsequently at high loads. For this reason, engines that are operated on a cyclic basis, with alternating periods of low- and high-load operation, are seldom troubled with fuel oil deposits on the exhaust valves.

Laboratory tests have shown that certain fuel qualities, such as low volatility or low cetane number, tend to cause greater amounts of valve deposits. However, operating conditions can have a substantial effect on the formation of these deposits and may outweigh the influence of fuel differences.

Exhaust-valve deposits originating from the lubricating oil are caused by the carbonization or burning of lubricating oil that has passed down the valve stem from the guide. With straight mineral or low detergent oils, the deposits usually form on the stem immediately below the guide and are often harmless unless they build up to an extent that causes valve sticking. When lubricating oils of higher additive content are used, the valve deposit is an incombustible ash that generally forms on the lower portion of the valve head. Being incombustible, it is not burned off by subsequent high-load operation of the engine, although alternate heating and cooling of the valve may cause the deposit to crack and chip off.

The ash deposit on the valve face may cause poor seating and combustion gas leakage. Hard particles of the deposit may indent the valve face, producing a Brinelling-type damage and causing poor seat closure. Cracking or chipping of the deposit leads to combustion gas leakage, guttering, and burning. Valve burning is essentially a high-load type of failure caused by overheating of the valve as a result of gas leakage. Nonleaking valves do not burn.

In general, the higher the ash content of the lubricating oil, the greater is the likelihood of excessive valve deposits and valve burning. However, there was little consistency in the reported experiences. One panel member stated that his company

This article is based on discussion about exhaust valves presented by these panel members:

H. V. Nutt, Chairman
USN Engineering Experiment Station
A. R. Schrader, Secretary
USN Engineering Experiment Station
Hans Gadebusch
Detroit Diesel-Engine Division, GMC
Leonard Raymond
Socony-Vacuum Oil Co., Inc.
R. A. Pejeau
Cleveland Diesel-Engine Division, GMC
C. C. Moore
Union Oil Co. of Calif.
W. B. Bassett
Lubrizol Corp.
J. W. Vollentine
Caterpillar Tractor Co.
L. A. Wendt
Shell Oil Co.
L. G. Schneider
USN Engineering Experiment Station

Table 1—Spectroscopic Analyses of Valve Ash Deposits

	Deposit "A", %	Deposit "B", %
Potassium	0.1	Trace
Barium	30.0	50.00
Calcium	10.0	—
Aluminum	5.0	0.07
Lead	3.0	0.20
Iron	1.0	4.00
Magnesium	1.0	0.04
Sodium	1.0	2.00
Phosphorous	—	5.00
Silica	3.0	0.40

had a record of thousands of hours of successful operation with high ash lubricating oils, although five deposit-caused valve burning failures had been experienced under laboratory conditions. Another told of an instance wherein light face deposits had actually appeared to improve valve seating. Another said that his experience showed no real correlation between the amount of valve deposits and valve burning. It appeared that the use of high ash lubricating oils did not in itself lead to valve burning failures. Other factors, such as severity of operation, engine design, and operating period between overhauls seemed to be highly important.

Spectroscopic analyses of valve ash deposits showing their oil source are given in Table 1.

The following formula was presented as including all the factors having to do with valve condition:

Valve condition = Hours at load × metallurgy × function of additive × (rate of additive addition—scavenging ability)

In this formula:

Rate of additive addition = Lubricating oil consumption × ash content of oil

Scavenging ability = Exhaust gas velocity × temperature × mechanical function (that is, valve train, seating rate, rotators, and so on)

While it was admittedly difficult to assign definite values to the several terms, the formula appeared to be of value in that it defined the relationship of the various factors involved.

There was some disagreement as to whether deposit problems and valve operating conditions were different for 2- and 4-stroke cycle engines. Some thought that these problems should be less severe in 2-stroke cycle engines because of the lower valve temperature resulting from the greater proportion of excess air used by these engines. Others said that their experience showed no particular difference in the valve problems of the two types of engines. It was pointed out that it had been found generally necessary to use the same valve materials for both 2- and 4-stroke cycle engines and it followed that the operating conditions were probably not much different.

Railroads have had relatively little difficulty with valve deposits in their locomotive engines. This is due to such factors as the relatively few users of high ash lubricating oils and the cyclic nature of locomotive operation where there are alternate periods of light- and heavy-load running. However, some locomotive types of engines have had valve deposit difficulties when operated with heavy and continuous loading, as in stationary powerhouse service, even when using the same lubricating oil that had been found satisfactory in railroad service.

"Heavy-duty" lubricating oils having moderate additive levels are generally used in locomotive diesel engines. In those engines using straight mineral or low additive oils, exhaust-valve-stem deposits have caused some troubles. Increased valve-stem to guide clearances have been effective in minimizing these problems. However, this expedient reduces effective valve life since maximum allowable stem clearance is reached sooner.

Railroad diesel fuels are usually of high quality and little difficulty has been experienced with valve deposits from this source. One engine manufacturer reported that the valves of engines used in heavy freight service with fuel of 0.8 to 1.0% sulfur content were in poorer condition than normal, although no unusual maintenance was required.

Railroads have found that close attention to valve mechanical factors is important. Used valves are carefully checked for cracks before reinstallation and proper valve keeper installation is emphasized. Proper maintenance of intake air filters is considered important as some instances of excessive valve-seat wear were ascribed to airborne abrasives.

At present, the exhaust valves are not a controlling factor in railroad engine overhaul periods. However, if engine improvement should permit longer overhaul periods, valve problems may become more serious.

Valve designs can be developed for succesful operation with high ash lubricating oils. Together with other factors, attention must be given to the minimizing of distortion that may cause valve leakage during operation. Such valve design development is justified in an engine that can take advantage of the beneficial properties of high additive oils. However, if the oil industry can develop oils that will be equally satisfactory from the standpoints of wear, piston deposits, and valve deposits, a more economical valve design may be used.

Possible means of minimizing the effects of valve deposit problems were proposed as follows:

(a) Improved valve materials. Higher nickel contents appeared to improve valve resistance to guttering and burning. Corrosion of valve materials is not often involved, but when such corrosion does occur, the resulting corrosion products sometimes help to hold deposits. Ordinarily, valve materials do not in themselves affect deposits. When a change in material does affect deposit formation, it is generally a result of changed valve temperature due to different design or heat transmission factors.

(b) Valve rotators. Users disagreed about their effectiveness. In some instances they appeared to reduce the buildup of seat deposits and in other cases, their value was questionable. One panel member reported Brinelling-damage to rotator components that indicated a probable short effective life.

(c) Reduced lubricating oil flow to valve stems. No more lubricating oil should be supplied to valve stems than is required for their lubrication. Any excess oil simply becomes available for the formation of deposits.

(d) Proper selection of lubricating oils. High ash

lubricating oils were developed to meet a definite engine need. As such, their use is indicated in certain engines operating under severe conditions. However, they should be used only when they are definitely required by the engine design, operating conditions, or use of a lower-grade fuel oil.

(e) Valve design. Design factors lowering valve temperature and minimizing the distortion of valves and valve seats are helpful in reducing deposits. Use of valve face and seat interference angles is sometimes helpful in cleaning deposits from valve seats and preventing their excessive buildup.

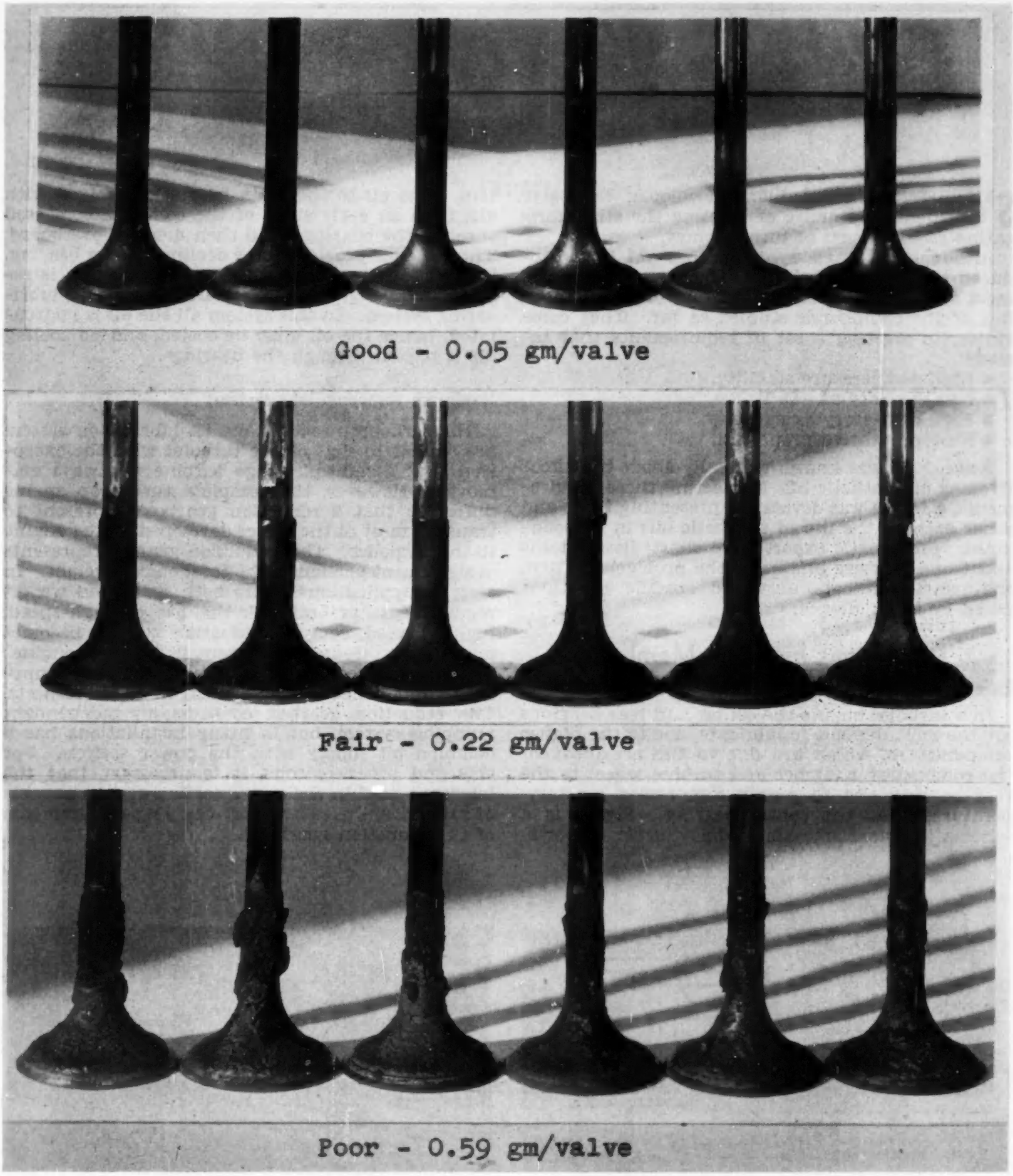


Fig. 1—Typical exhaust-valve deposits. Exhaust valves are from three runs in a popular 2-stroke high-speed diesel, and indicate three levels of stem and fillet deposit. Upper set of valves, with 0.05 g deposit per valve, shows essentially no deposit, while the intermediate group, with 0.22 g deposit per valve, is fair. A poor condition is shown in the lowest group of valves, in which the deposits averaged 0.59 g per valve

SYNTHETICS Help Meet

SYNTHETIC oils are being developed that give considerable promise of meeting the stiff lubricating requirements of turboengines.

Although no single synthetic has yet been produced that is completely satisfactory, the diesters seem to have the best combination of characteristics of the compounds studied so far. They come closest to meeting a set of requirements that include:

- High-temperature stability.
- Low viscosity at −65 F.
- High load-carrying capacity.
- Rust-preventive properties.

Since little was known generally about the effectiveness of synthetic oils in meeting these requirements, a forum was devoted to presenting these and other data on the use of synthetic oils in turboengines. First, each expert gave short dissertations about one or more phases of the problems. Then, the panel members answered specific questions posed by the audience.

Discussions by Panel Members

Blair on engine and oil systems:

In a turbojet engine the center and rear bearings are the most difficult to lubricate, due to the higher temperatures, which are due to the proximity of the combustion chamber and turbine wheel to the rear bearing and to highly compressed air temperatures near the center bearing. Fig. 1 is a schematic of a waste-air oil-mist lubrication system. The oil to the main bearings is mixed with air, from an early stage of the compressor, passed through the bearings, and then dumped overboard. Thus, the air provides some cooling for the bearing. The oil to the gears in the accessory section is recirculated. Fig. 2 is a schematic of a closed lubricating system. In this system all the oil is recirculated, hence the oil must be cooled, and no cooling air is passed through the bearings.

Hardin on turboprop lube system:

The turboprop section and its lubrication system are similar to that of the turbojet with the exception that a multiple-stage turbine is always employed. However, the complete turboprop engine differs in that a reduction gearbox is present to transmit most of the power developed by the engine to the propeller. This reduction gearing represents a significant portion of the total engine weight. In aircraft applications where both space and weight requirements are critical, the use of high-speed, highly loaded, complex reduction gearing becomes mandatory. Gears are present in turbojet engines for driving accessories but are not major components and hence not as critical in these respects. The reduction gearbox contains an independent pumping system, but in many installations has a common oil supply with the power section. For this and other reasons, it is necessary that the lubricant used in the power section also be capable of satisfying the severe load-carrying requirements of the reduction gearing.

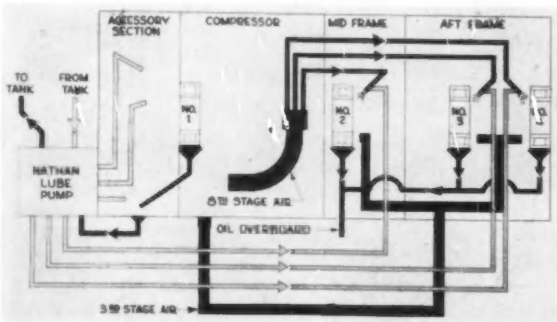


Fig. 1—Air oil-mist lubricating system

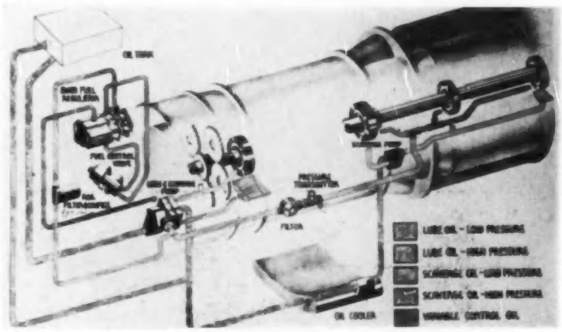


Fig. 2—Closed lubricating system

Stiff Lube Needs of Turboengines . . .

• High-Temperature Stability
• Low Viscosity at -65F
• High Load-Carrying Capacity
• Rust-Preventive Properties

R. I. Cross, United Aircraft Products, Inc.

Based on secretary's report of Question-and-Answer Forum on "Synthetic Oils for Aircraft Gas Turbines" held during the SAE Annual Meeting, Detroit, Jan. 14, 1953.

Fuel dilution of the lubricant, as practiced with reciprocating engines, is not suitable for turbine powerplants, due to the lower volatility of the turbine fuels and to operating characteristics of the engines. Preheating of oils is not deemed a desirable solution to aid cold starting.

Drabek on future trends in turbojet engines:

Engines are being designed with greatly increased pressure ratios—the air will be compressed up towards 15 times the inlet pressure, whereas in most of today's engines it is compressed approximately 5/1 and 6/1. This will mean higher temperatures for the air and metal structure around the bearings. The future is also bringing higher flight speeds,

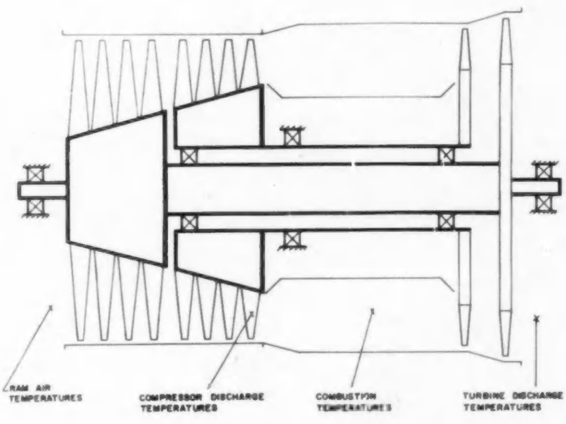


Fig. 3—Schematic diagram of dual rotor engine

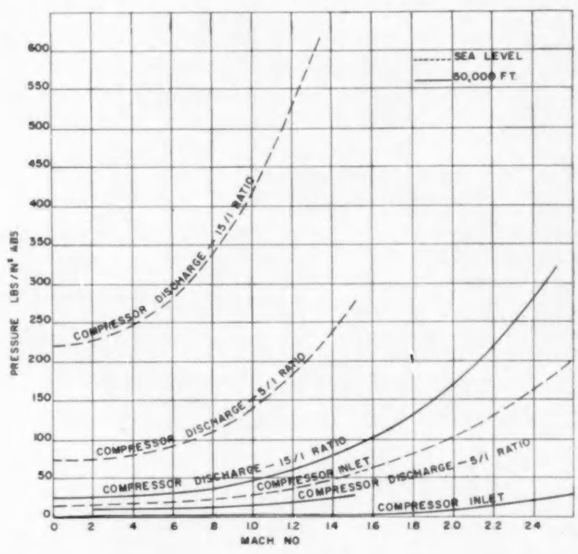


Fig. 4—Compressor air pressure versus air speed in Mach number

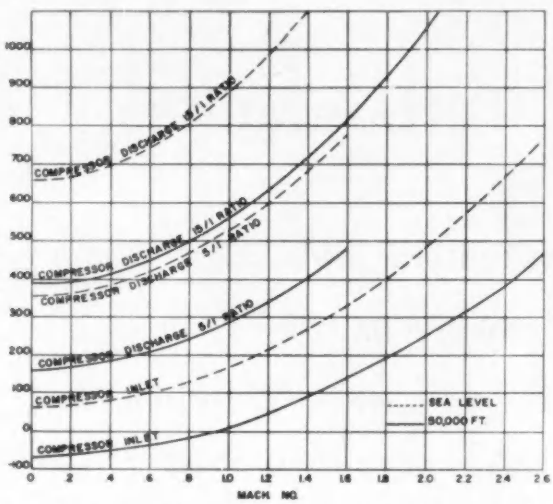


Fig. 5—Compressor air temperature versus air speed in Mach number

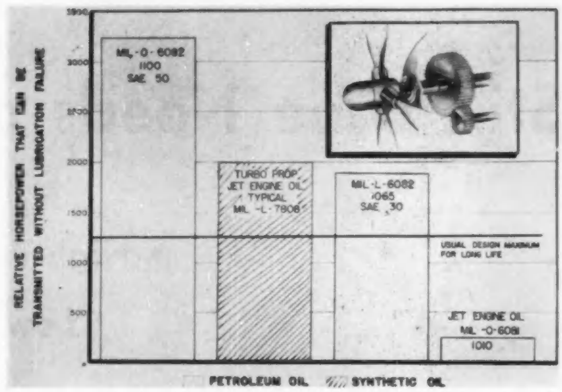


Fig. 6—Relative power that can be transmitted without failure for various petroleum and synthetic oils

which result in high inlet air temperatures due to the ram-air effect, which further aggravates the heating and makes cooling more difficult by raising the "sink" temperature.

Fig. 3 is a schematic diagram of a dual rotor engine. This engine requires lubrication for more bearings, which are larger and more highly loaded. Note how the high-temperature portions of the engine completely surround the bearings.

The effects of high pressure ratios on the compressor discharge pressure at different air speeds are shown in Fig. 4.

Fig. 5 is a plot of compressor air temperature versus Mach number. This curve shows the magnitude of the air temperatures which must be considered in flying at high flight speeds with both low and high pressure ratio engines.

Murray on the three main characteristics required in synthetic oils:

a. Low-temperature pumpability or low viscosity at −65 F. It was pointed out that the English designers are using −40 F for their low-temperature starting requirements. Present mineral oils, although satisfactory for normal temperatures, are too viscous at −65 F.

b. High-temperature stability. Present mineral oils are occasionally subjected to higher temperatures on shutdown called "soak-back." However, these are of short-time duration.

Hydraulic oils are not usable because of the temperature at which the bearings are operating. Due to the higher working temperatures brought about by higher speeds, the ram-air effect, and higher compression of the air, new alloys and bearing designs are being used, hence the lubricating oils must be capable of performing at higher temperature. Mineral oils boil off their lower fractions at these temperatures.

c. Higher load-carrying capacity. In the discussion of the dual rotor engine (Fig. 3), it was pointed out that the synthetic oils must have a greater load-carrying capacity to accommodate the increase in number of bearings, and also for the reduction gear in the turboprop version.

Fig. 6 shows the relative horsepower that can be transmitted without failure for various petroleum and synthetic oils.

THE following experts served on the panel of the question-and-answer forum on synthetic oils suitable for aircraft gas turbines:

F. E. Carroll, Leader
United Aircraft Products, Inc.

R. I. Cross, Secretary
United Aircraft Products, Inc.

R. W. Blair
Wright Aeronautical Division
Curtiss-Wright Corp.

M. C. Hardin
Allison Division
General Motors Corp.

Stephen Drabek
Aircraft Gas Turbine Division
General Electric Co.

H. A. Murray
Texas Co.

E. F. H. Pennekamp
Esso Laboratories
Standard Oil Development Co.

E. L. Margolin
Wright Air Development Center

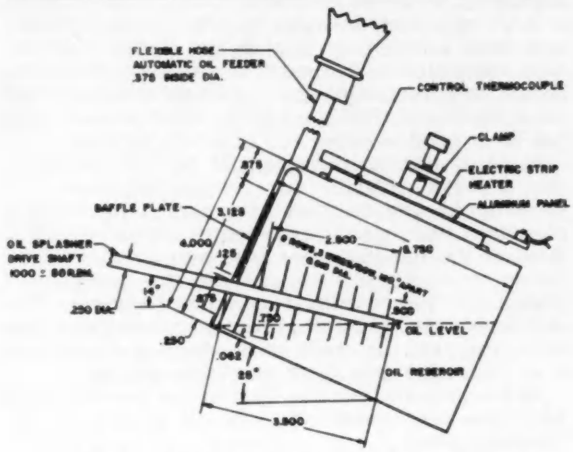


Fig. 7—Schematic diagram of coking test assembly

Hardin on the effects of diesters on organic materials:

The organic materials, such as rubber seals and hose, plastics, protective coatings, and similar materials currently used in engine and airframe installations, have been developed or adapted for use with petroleum lubricants; and their resistance to these oils was one factor considered in their selection. The same problem is present with the use of diester oils in that these petroleum-resistant materials may or may not be compatible with these oils. Test programs by various organizations in industry and the military services are currently in process on various phases, but an increased awareness of this problem is needed throughout the aircraft and its associated industries; and additional investigations into the effects of these oils on the multitude of materials which may be in continuous, intermittent, or accidental contact with them are necessary.

At Allison we have found that the petroleum-resistant buna N synthetic rubber parts procured to AMS or military specifications are, in general, swelled excessively by these diesters or otherwise deteriorated to the extent that they are unsuitable or definitely marginal. Through the cooperation of the rubber fabricators and Wright Air Development Center, buna N stocks have been specially compounded or selected which have given creditable service in seals where the exposure temperatures are within the limits suitable for buna N applications. Selected silicone stocks have been found usable where the diesters do not contain extreme-pressure additives. However, we have indications that a full cure of silicones is necessary for maximum oil resistance.

Work is also in process on other high temperature seal materials for use with these oils. The useful life of military specification hose in test stand assemblies has been found to be sharply reduced by swelling, softening, and subsequent erosion of the inner liner. The hose problem is also present in airframe installations, and no proved solution is currently available. Many organic coatings, including lacquers and silicone resins, are, by our experience, severely attacked. A heat convertible glyceryl phthalate engine enamel and a phenolic resin coating have demonstrated satisfactory resistance. We have an indication that some plastics and other insulating materials are deteriorated by these oils or their vapors and are currently, with the cooperation of our suppliers, determining what materials substitutions may be necessary in engine electrical systems.

It should be emphasized that the characteristics related herein are based upon a limited number of materials of the various types mentioned and may not necessarily be typical of all materials of that particular type. With our present knowledge it is necessary that each material with which these oils may be in contact be investigated as to their resistance to this family of oils and that conditions of exposure be carefully considered. It should also be remembered that various diester base stocks may differ in their effects on some of these materials.

Pennekamp on the performance of synthetic lube oils:

Crampton, Gleason, Lifson, and Pennekamp[1] have already discussed this subject. In their paper they

Fig. 8—Typical coking test installation

[1] "Performance of Turboengine Synthetic Oils," by A. B. Crampton, W. W. Gleason, W. E. Lifson, and E. F. H. Pennekamp. Presented at SAE National Fuels & Lubricants Meeting, Tulsa, Okla., Nov. 7, 1952.

Table 1—Physical Properties of Ester-Type Synthetic Oils

	Oil A	Oil B	Oil C
Viscosity at 210 F, cs	7.9	3.6	3.1
-40 F, cs	12,500	1,900	1,500
-65 F, cs	[a]	13,000	10,000
Pour Point, F	-65	<-75	<-75
Flash Point, F	450	430	400

[a] Too high to measure.

Table 2—Load-Carrying Capacity of Ester-Type Synthetic Oils

	Viscosity at 210 F, cs	Relative Gear Scuff Load, % of grade 1100
Synthetic Oil: A	7.9	105
B	3.6	60
C	3.1	45
Mineral Oil:		
Grade 1010	2.5	< 15
Grade 1100	20.5	100

Table 3—Low-Temperature Pumpability of Ester-Type Synthetic Oils

	Viscosity at 210 F, cs	Temperature Range for 5000- to 20,000-Cs Viscosity, F
Synthetic Oil: A	7.9	-25 to -45
B	3.6	-55 to -70
C	3.1	-60 to -75
Mineral Oil:		
Grade 1010	2.5	-45 to -60
Grade 1100	20.5	+5 to +30

Table 4—Volatility of Ester-Type Synthetic Oils

	Viscosity at 210 F, cs	Relative Evaporation Rate at 400 F, % of grade 1010
Synthetic Oil: A	7.9	2
B	3.6	3
C	3.1	10
Mineral Oil:		
Grade 1010	2.5	100
Grade 1100	20.5	1

Table 5—High-Temperature Stability of Ester-Type Synthetic Oils

	Viscosity at 210 F, cs	Oxidation-Corrosion Stability at 347 F, 72 Hr
Synthetic Oil: A	7.9	Stable, noncorrosive
B	3.6	Stable, noncorrosive
C	3.1	Stable, noncorrosive
Mineral Oil:		
Grade 1010	2.5	Unstable, corrosive
Grade 1100	20.5	Unstable, corrosive

attempted to select synthetic oils by, first, listing a large group of desirable quality characteristics, and then attempting to rate the performance of each oil tested under each of the characteristics. Hence, it is inevitable that some compromises had to be made and that oils best in some respects may not be as good as other oils in other respects.

Some of the desired qualities for the synthetic oils are low volatility or evaporation rate, low viscosity at low temperature, high load-carrying capacity, and good high-temperature stability. Some of the materials that have been considered for use as synthetic oils are the diesters, polyglycols, phosphate esters, silicates, and silicones. The sources for the synthetic lubricants are rather broad since they can be made from chemicals produced from animal, mineral, or vegetable origins.

At the present time the diesters are considered to have the best combination of all-around quality characteristics.

Tables 1–7 demonstrate the comparison of physi-

Table 6—Performance of Lubricants in Advanced-Design Turbojet Engines

	Mineral Oil Grade 1010	Ester-Type Synthetic Oils		
		A	B	C
Viscosity at 210 F cs	2.5	7.9	3.6	3.1
Gear and Bearing Lubrication	Scuffing and wear	Excellent	Good	Acceptable
Oil Consumption	Excessive	Low	Low	Low
Deposits	Medium to heavy	Light to medium	Light to medium	Light to medium
Low-Temperature Pumpability Limit	-40 to -65 F	-40 F	-50 to <-65 F	—

Table 7—Performance of Lubricants in Advanced-Design Turboprop Engines

	Mineral Oils		Synthetic Oils	
	Grade 1100	MIL-O-6086(M) Mild E-P	A	B
Viscosity at 210 F, cs	20.5	8.6	7.9	3.6
Gear and Bearing Lubrication	Good	Good	Good	Fair
Deposits	Medium to heavy	Very heavy	Light to medium	Light to medium
Corrosion	None	Some	None	None
Low-Temperature Pumpability Limit	30 F	——	-40 F	——

cal characteristics of three synthetic oils A, B, and C with either mineral oil grade 1010 or 1100.

Table 1 shows the physical properties of ester-type synthetic oils. Table 2 shows the load-carrying capacity of ester-type oils as measured in high-speed gear test rigs using grade 1100 mineral oil as the reference oil.

Temperature for the 5000- to 20,000-cs viscosity range is shown in Table 3. This is the desired viscosity range for pumpability required for cold starts at −65 F. Volatility, the factor to be considered to prevent excessive oil consumption when operating at high temperature, is shown in Table 4. The oxidation, thermal stability, and corrosion characteristics are shown in Table 5. Tables 6 and 7 show the performance of the lubricants as tested in turbojet and turboprop engines of advanced design.

In concluding his discussion he stated in answer to the initial questions that the diester-type synthetic oils are the best available today when considering all the quality characteristics. However, experience to date has shown that further work should be done to produce even better performance in gas turbine engines. Further improvements in high-temperature stability and load carrying characteristics appear desirable. In addition rust-preventive properties are desired by the military in synthetic oils.

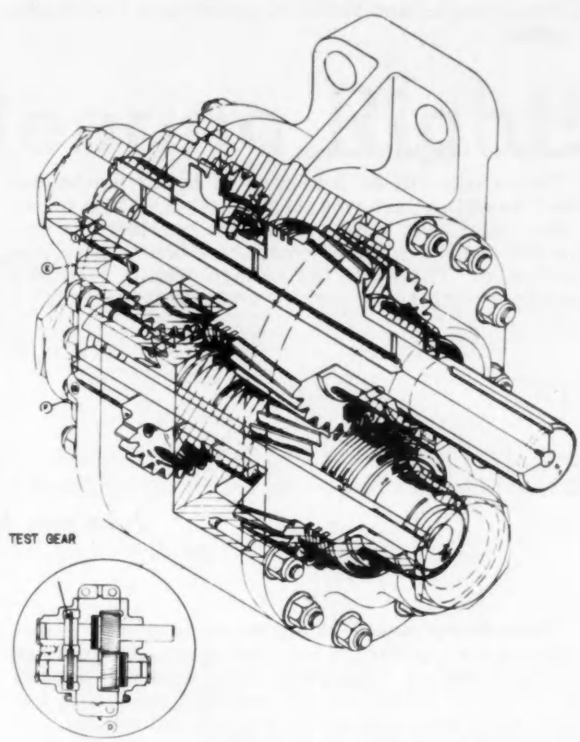


Fig. 9—Cutaway of gear test rig

Margolin on the status of specification MIL-L-7808:

Revision A, which was dated Nov. 25, 1952, should be published and available sometime during January, 1953. Revision A corrected a few deficiencies in the specification. Two new major tests were added. They are the panel coking test and the gear test (Ryder Gear). Fig. 7 is a schematic diagram of the coking test and Fig. 8 is a photograph of a typical coking test installation. Fig. 9 is a cutaway of the gear test rig. A new test for corrosion using silver and copper at 450 F has also been added.

Blair on company tests:

Fig. 10 shows photographs of the results of some tests which my company has run, using three different oils in this rig, which ran at 8300 rpm with the bearing outer race temperature of 700 F. The bearing rig was still operable at the end of all tests,

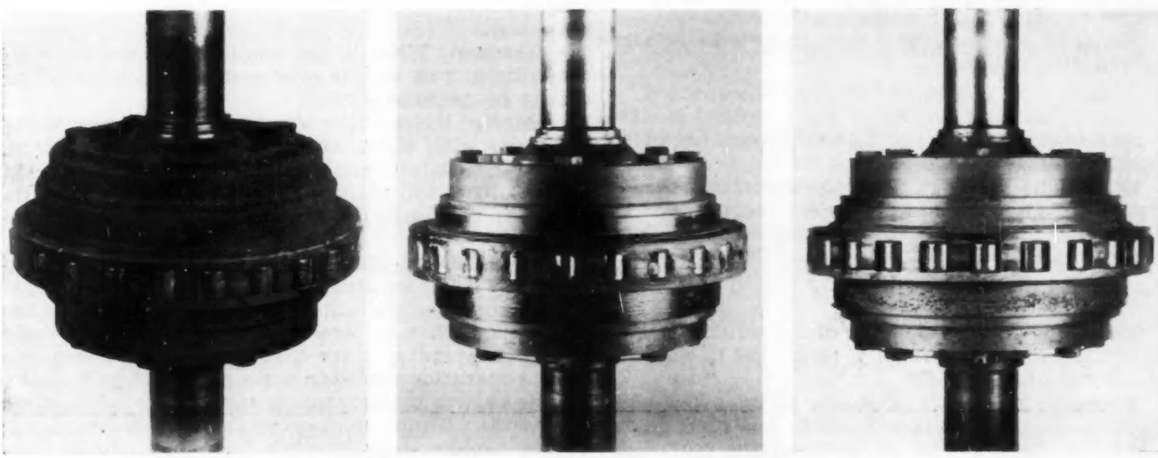


Fig. 10—Test results with three different oils in gear test rig

however, the one oil showed little deposit, the other heavy deposits, and the third heavy gum and slight deposit.

Murray on new test methods:

Better oils will be perfected as better yardsticks for measuring performances are set up. The panel coking and gear tests will require considerable experiences from a lot of companies before they are perfected. There are not enough testing facilities equipped with these tests to evaluate them fully.

Blair on costs:

Although present cost of the synthetic oil is approximately $9 per gal, the cost per flight hour is very small in comparison with other operating costs such as fuel consumed. This is due to the extremely low oil consumption, which is due in part to the low volatility of the synthetic oil, at the working pressures and temperatures, as compared with petroleum oils and in part to the basically lower oil consumption of jet engines as compared with piston-type engines. Further, the cost per gallon of the oil will decrease as more companies produce the oil and as additional sources for the base stocks are developed.

Questions and Answers

Pennekamp stated in answer to a question concerning composition of oils that most additives are of a proprietary nature and those used will depend to a certain extent on the company producing the oil. Additives such as detergents, inhibitors, and load-carrying agents must be chosen on the basis of their effect on the overall quality of the oil. They should not adversely affect low-temperature flow characteristics, load-carrying ability, metal corrosion characteristics, volatility, high-temperature stability, and the like.

Question: What is the abrasive effect of the synthetic oils? Is the nature of the corrosion encountered from galvanic action? What is the nature of the oxide film?

Murray: There are insufficient test rigs operating from which data can be collected. As more test rigs are installed more accurate answers to the above question will become available.

Blair: In our 7-hr–700 F tests there were no signs of abrasive action.

Question: Was the 700 F the temperature of the outer race?

Blair: The bearings were contained in a heated housing. The temperatures were recorded on the outside of outer race. The bearings were still functioning satisfactorily at the end of the test.

Question: Is there sludging of the inhibitors when operating for long periods of time—150 hr—at temperatures above 300 F?

Drabeck: There is sludging even after short periods of time. This is possibly due to the components added to the oil to meet the high load-carrying ability that is part of the present specification. This sludging makes the present oils unattractive.

Margolin: The oils show the same physical characteristics after depositing out the sludge as before. Hence, one solution would be to filter out the sludge.

Pennekamp: The nature of sludge formed at high temperatures and the best way to eliminate this difficulty is receiving considerable attention.

Question: How can these oils be used at temperatures of 700 F when the flash point is stated as slightly above 400 F?

Murray: The flash point—say 435 F—is the point at which the lowest fractions begin to evaporate or boil off. Actually, in order to flash there would need to be present oxygen and a flame. Hence, without these two items, more and more of the lower fractions are boiled away.

Question: What is the relative rate of attack on synthetic hose by the synthetic oil as compared to that by petroleum oils?

Hardin: Buna N hose available has not been satisfactory with the synthetic oil. I cannot express the relationship quantitatively but our replacement rate of hose in stand installations using synthetic oil has been a lot higher than when mineral oil is used.

Pennekamp: The rate of attack on rubber in storage is low because storage temperatures are low. Under engine operating conditions the rate of attack is higher in some locations where extremely high temperatures are encountered. However, engine operating periods are usually short so that the time at high temperature is spread over a long time interval. Thus, when difficulties are encountered, they usually show up when long-time engine tests are run.

Install That Bearing Right!

L. E. Schamadan Jr., Cleveland Graphite Bronze Co.

Based on paper "The Cost of Adequate Bearing Maintenance" presented at a meeting of SAE Northwest Section, Sept. 18, 1953; SAE Spokane-Intermountain Section, Sept. 22, 1953; SAE Oregon Section, Sept. 23, 1953; and SAE British Columbia Section, Oct. 5, 1953.

FLEET operators can do many things to get more mileage out of engine bearings. But if they don't get off on the right foot by installing bearings properly, letter-perfect maintenance later on won't pay the dividends it should.

There are seven easy-to-follow guideposts to a good bearing installation:

1. Keep Parts Clean

Identify and lay out all parts on a clean piece of paper. Watch for dirt on bearing backs and parting-line surfaces!

2. Watch Those Torque Wrenches

Check the condition of bolts and bolt-head seats to make sure that torque wrench readings are true indications of bolt tightness. Distortions caused by uneven bolt torques cause trouble.

3. Obtain Proper Rod Bore Finish

A 50 to 80 microinch finish will provide adequate contact for good bearing performance. This finish is easily obtained by boring.

4. Be Sure Oil Clearance Is Right

Measure the oil clearance to make sure that it is right.

The inside diameter of the assembled bearing can be measured with inside micrometers if dial-indicator bore gages are not available. The journal diameter is best measured with micrometers that read in ten-thousandths of an inch.

Plastigage may also be used for checking bearing clearances. However, extreme care should be exercised to eliminate false readings caused by housing-bore or main-journal misalignment. When making the check, an attempt should be made to use the largest journal diameter if out-of-roundness exists, because minimum clearance is the critical condition.

Still another method for checking bearing clearance involves use of brass shims. With this system, a shim that is shorter than the bearing and about ¼ in. wide should, when clamped between the shaft and bearing, allow the shaft to turn easily. A shim 0.001 in. heavier than the required clearance should lock the shaft from rotation. This type of check requires experience and care to avoid damaging the bearing inserts. It is made with all bearing caps loose except for the position under consideration. The correct torque should be applied to the clamping bolts.

Be sure to follow the manufacturer's recommendations on shaft clearance and end clearance!

5. Check Connecting Rod Alignment

The centerline of the piston-pin hole should be parallel (within 0.001 in. in 6 in.) to the centerline of the big end. This will limit both twist and bend, hence the cause of a great many bearing failures will be eliminated.

6. See To It That Bearings Fit the Housing

Spend a few extra minutes to make sure of the fit of the bearings in a rod or main saddle.

If you suspect that the bearings are loose, apply a light coating of prussian blue to the housing, insert the bearing shells carefully, and torque the nuts. Then break the assembly and remove the

shells without smearing the blue transferred to the bearing backs. An 80 to 90% transfer insures that the bearings are adequately seated.

7. Permit No Shaft Binding

With the mains properly tightened, and without the rods and seals in place, the shaft should rotate freely. Any binding should be traced and its cause removed!

The best way to make this check is with the block mounted on a stand. Put a light, uniform coating of blueing on the shaft, then place the shaft on the journals. After rotating the shaft several revolutions, turn the block over and rotate the shaft again.

The nature of the transfer of blue to the bearing shells will reveal a lot about the life expectancy of the bearings. Blue in the parting line areas is a bad sign. Lack of contact on a bearing also spells trouble. It could be excessive clearance or misalignment of the shaft and/or case bore. A decent blue pattern covering 45 to 90 deg at the center of all bearings is an indication that the bearings will give good performance.

This check also presents a good opportunity to pick up evidence of hour-glass journals, taper, shaft burrs, and fillet ride.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Electron Microscope . . .

. . . offers new means for studying detergent oil performance. May prove useful in development of improved engines and lubricants.

Based on paper by **J. B. Peri,** California Research Corp.

MARKED deterioration in the performance of a detergent oil may correspond to changes in dispersancy not readily detectable by usual tests. The electron microscope enables these changes to be observed and studied. Periodic piston inspection during an engine test, coupled with examination of oil samples with this microscope, often permit the deposition rate of an oil to be related to the degree of dispersion of particles suspended in the oil.

Fig. 1 shows the build-up of piston land deposits during laboratory diesel engine tests of straight mineral oil and of a low level detergent oil (approximately 1% detergent by weight). These piston ratings were obtained in special runs by shutting down the engine at intervals and removing the piston. A visual rating was used in which complete blackening of a piston land was rated 100.

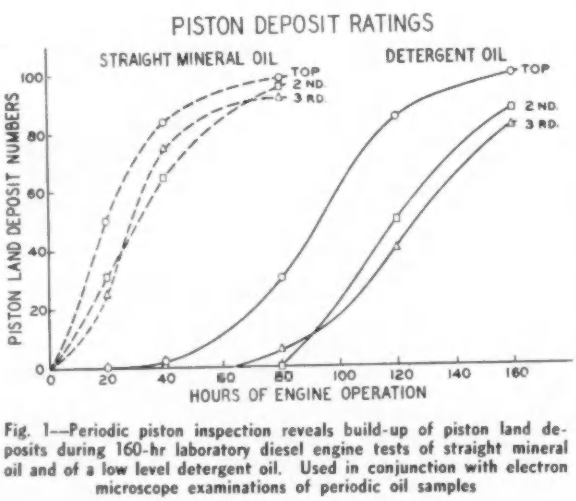


Fig. 1—Periodic piston inspection reveals build-up of piston land deposits during 160-hr laboratory diesel engine tests of straight mineral oil and of a low level detergent oil. Used in conjunction with electron microscope examinations of periodic oil samples

Electron microscope examinations of oil samples taken at 20-hr intervals in the above test, permit the depositing characteristics of the oil to be related directly to its appearance. After 20 hr of engine operation, the dispersion of particles present in the oil is excellent. Small single particles less than 300 Angstrom units in diameter are still present in large numbers. They are probably composed of detergent plus resins and gums and they show little or no tendency to flocculate.

At 40 hr, the small single particles present display a tendency to cluster, forming small floccules containing from two to ten primary particles. The engine data (Fig. 1) shows formation of piston deposits beginning at about this time. The 60-hr sample shows definite flocculation. The small floccules are larger than in the previous sample, averaging perhaps 1000 Angstroms in diameter, and they readily pass through ordinary filters.

The dispersion of suspended material in the oil sample is still excellent by usual criteria. However, the engine data shows the detergent oil no longer preventing disposition at this point, although the deposition rate is still below that of straight mineral oil.

The 80-hr sample shows little further change, but by 100 hr aggregation of small floccules to form fairly large particles is quite marked. Many of the large particles can now be removed with a good filter. At 120 hr, large clusters of colloidal particles predominate. The small, well dispersed floccules are disappearing as they become bound up in the larger agglomerates. The effect of the detergent additive has almost completely vanished.

The detergent oil at 160 hr closely resembles a used uncompounded mineral oil at 40 hr. Agglom-

erates are large and can be removed to a considerable extent by efficient filtration. The oil is almost free of extremely small colloidal particles.

These samples were examined at a magnification of about 32,000X. No flocculation could be detected under the light microscope at 500X for any of the samples.

Studies of this type permit correlation of the deposition rate of an oil with its appearance under the electron microscope. Thereafter, the appearance of used oil samples can be used to indicate the detergency level of the oil in actual service. (Paper "An Electron Microscope Study of the Performance of a Detergent Oil" was presented at SAE National Fuels and Lubricants Meeting, Chicago, Nov. 5, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Turboprop Control Systems . . .

. . . should have a minimum of functions acceptable to operating crew. Pressure for "extra features" may bring about unreasonable complications.

Based on paper by **Thomas B. Rhines,** United Aircraft Corp.

IN current efforts to provide rational treatments of the reliability problem for turboprop control systems, we must rely largely on judgment of the adequacy of the components. This is usually a qualitative evaluation because we lack good quantitative information.

The process is, however, one in which quantitative thinking is possible. As skill improves, use will be made of numerical evaluations. It will be possible to set a numerical goal for the probability of each failure, in the light of the consequences of that failure. Numbers will be assigned to the failure risk of each part and arithmetic (from probability theory) will show the expected overall probability of failure for comparison with the goal. Until this day arrives, we must get along with qualitative recognition of the principles:

- More functions mean more parts.
- More parts mean more failures.
- "Safety devices" reduce the consequences of failure.
- "Safety devices" add more parts.
- Stronger parts mean fewer failures.
- Fewer failures mean fewer "safety devices."

Until the turboprop becomes well established in field experience, we should demand in its control system the least number of functions that can be accepted by the operating crew. Whether the system shown in Fig. 1 or Fig. 2 is representative of this number is again a question of judgment. If Fig. 1 with its safety devices is enough, there is no serious problem of reliability, since this array is simpler than other systems that are known to be serviceable. Fig. 2 is perhaps slightly more complex than control systems already in use, but not enough so to be cause for alarm.

Service experience is now being accumulated with systems generally similar to those of Fig. 1, and extensive experimental experience is available at complexity levels comparable to Fig. 2. Unless the pressure for more and more "extra features" drives the level of complication out of reasonable grounds, there is no need to shy away from the turboprop on the grounds that "it's too complicated." (Paper "Turboprop Controls—How Complicated?" was presented at SAE Metropolitan Section, New York, Oct. 21, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

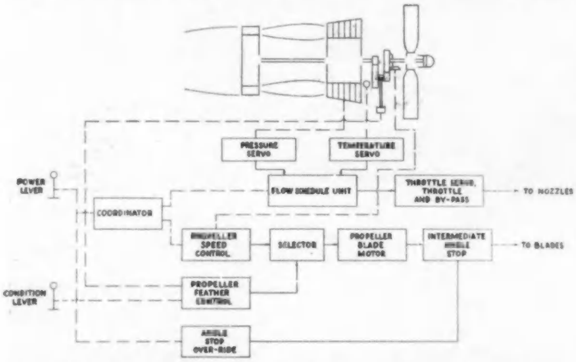


Fig. 1—Schematic diagram of turboprop control system with a minimum of functions. This is often considered unacceptable because too much care of engine is left in hands of pilot

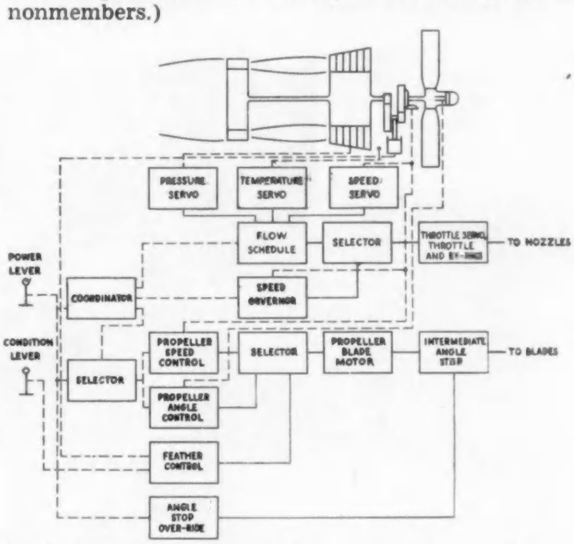


Fig. 2—Diagram showing a system which includes features for more completely automatic operation. Each box in these diagrams is intended to include about the same degree of complexity. Total of boxes suggests complexity of entire system

Punishing Tractors

Here is one of the roads that . . .

Fig. 1—Portion of the Arizona rock road on which the track link accelerated tests were conducted. A few of the larger rocks can be seen protruding through the surface

. . . punishes this kind of tractor.

Fig. 2—One of the test tractors on the rock road. Note that it is equipped with bulldozers on front and rear and a double-drum cable control unit on the rear

Makes Them Act Better

D. R. Richardson and G. R. Fuller, Caterpillar Tractor Co.

Excerpts from paper "Accelerated Testing of Tractor Components" presented at SAE National Tractor Meeting, Milwaukee, Sept. 15, 1953.

ACCELERATED testing of tractors and their component parts has become an important part of tractor development. It gives designers some idea of what their creations can and can't do long before this information could be obtained from normal testing or customer usage. Knowing this, designers can get the bugs out of a product before it is put in the hands of a customer.

Usually, the results of accelerated testing must be verified by normal testing if the accelerated test is to be considered valid. In some accelerated tests, however, the results are compared only to the results of other accelerated tests. The comparative results may indicate that one part is superior to another, but may not indicate the extent of superiority. The final evaluation must come from results of normal testing. In either case, accelerated test results must be reproducible . . . and viewed with caution until verified.

Caterpillar has devised many accelerated tests. Let's take a look at the ones that helped us to:

- Design track links with greatly improved life.
- Screen out steering-brake lining materials not worth field testing.

Track Links

Reports from customers indicated that track links were failing prematurely in some parts of the country. We had to find out why.

Tests were initiated at our Arizona proving ground (near Phoenix) early in 1951. Objective: to produce quick test results for a track link development program.

Test conditions had to be such that they would produce in a much shorter time cracked links exactly like those on customer's machines.

A rock road was laid out that extended about two miles up a valley at the toe of the White Tank Mountains. The test course also included a half mile of less rocky road extending into the desert. Fig. 1 illustrates a portion of the road and its general condition. The road was constantly maintained with a tractor and bulldozer to keep it as nearly smooth as possible with solid rock at its surface. A few of the larger rocks can be seen protruding through the surface. The road was made as long as practical in the interest of preserving uniformity through successive tests.

It was decided to operate two new D8 tractors, each loaded to a gross weight of approximately 50,000 lb, on the rock road in fifth gear. Each tractor was equipped with an angling blade bulldozer on the front; a double-drum cable control unit and a straight blade bulldozer on the rear. (This combination produced the desired gross weight without appreciably changing the center of gravity of the tractor.)

Fig. 2 shows one of the test tractors on the rock road. Note the unorthodox method of mounting the bulldozer on the rear of the tractor. A set of trunnions was welded to the "C" frame of the angling blade bulldozer. The rear bulldozer was mounted upside down so the blade weight was carried on the end of the drawbar.

Fig. 3 shows the action of the track as the tractor passed over a rock. The rock caused the track to form a ramp over which the tractor had to pass. As each roller left the ramp, the following roller

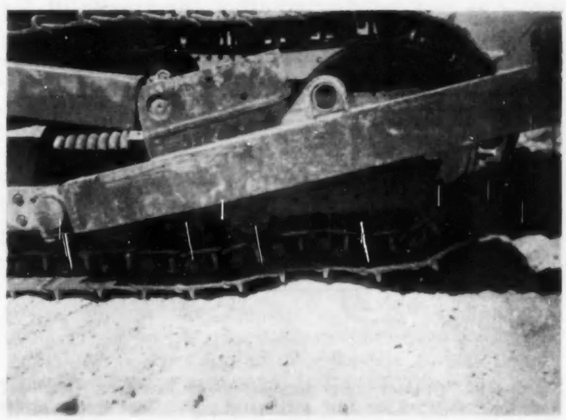


Fig. 3—When the test tractor passed over the surface rocks in the roadway, the track links received a severe beating from the track rollers

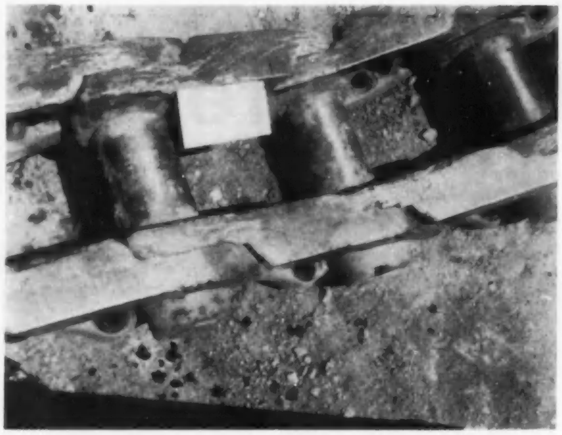


Fig. 4—The rail surface of these track links was severely damaged during a short accelerated test on the Arizona rock road

dropped onto the track causing terrific impact loads on the links. The roller then carried a large portion of the tractor weight until the next roller took over.

During the early days of the test operation, a very close watch was maintained to determine exactly what was happening to the track links. (The tractors were first equipped with production tracks of the type causing difficulty on some customer's machines.) After only 250 hr, just over two weeks, the links were cracked to the extent that there was a real possibility of breaking the tracks. Because of the dangers involved with track breakage when traveling in high gear on a mountain trail, the test on these particular links was terminated.

This test had proved, however, that we could duplicate field failures in an accelerated manner. The shortest times involved in field failures were considerably longer than our accelerated test time. We had succeeded in getting failures identical to field failures.

Fig. 4 shows some of the original test production links. The rail surfaces are very badly cracked and spalled. Though cracks cannot be seen in this view, many were present.

To facilitate reporting, a set of "standard" crack locations was established from the results of the first test. Fig. 5 defines these crack locations on a track link.

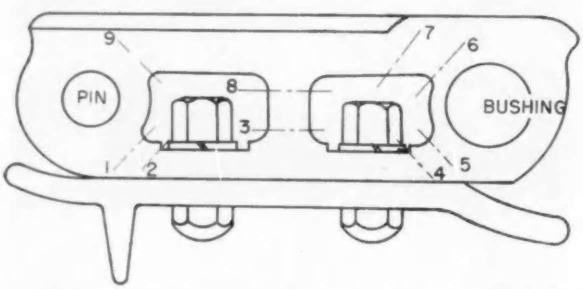


Fig. 5—The "standard" crack locations shown here were established from the results of the first accelerated test. They were used to facilitate reporting

The following figures emphasize the thoroughness of the first tests with the production track links. For a test period of 250 hr, and out of 104 links, 92% had cracks at the No. 9 location, 83% had cracks at the No. 3 location, and 39% had cracks at the No. 4 location.

As a result of these Arizona rock road accelerated tests, we were able to evaluate many hundreds of track links incorporating varied designs, varied heat treatment, and different metallurgy. From all this, it was possible to design links with greatly improved life. The same results could, no doubt, have been accomplished without accelerated testing, but only after a long, drawn-out program.

Steering-Brake Linings

In an effort to reduce the time, cost, and variables encountered in the field testing of steering-brake lining materials, we set up an accelerated test program at our Peoria proving ground. The tests which were carried out on a D8 tractor, were essentially screening tests to determine brake lining characteristics under controlled conditions. If the test material were equal to, or better than, the standard reference material, the material was sent into the field for further testing; if not, no further testing was deemed necessary.

A complete accelerated test on a lining material consisted of a series of controlled tests. In each of these different tests, the lining surface condition was varied from other tests to obtain a complete evaluation of the braking characteristics under a variety of conditions. These comparative tests were used to determine capacity at break-in, capacity under varying temperatures, resistance to and response after oil soaking, wear rates, heat-rejecting ability, and mechanical strength of the lining material.

A test installation consisted of one brake lined with the test material and the other brake lined with the standard reference material. With this split setup, both lining materials were subjected to the same external conditions during testing.

To reduce variables and the attendant's time to a minimum, an automatic control mechanism was designed to meet these requirements:

1. Each brake must do the same amount of work during each brake application for a given test.
2. The surface temperature of the brake drum must be held as nearly constant as possible at the initial application of the brake for a given test.
3. The cycle must be of a nature to simulate as nearly as possible actual operating conditions (but still be compatible with requirement number two).
4. The controls must be comparatively simple and versatile so that various phases of testing a given material can be changed to meet special requirements.
5. The controls must operate automatically without supervision except for periodic readings by non-technical personnel.

To meet the first three requirements, the settings for the automatic controls were predetermined

in field testing. To keep the amount of work constant for each brake application for a given test, the controls were set so that the brake would lug the engine from a high to a lower speed in a given number of revolutions. This condition gave fairly high energy loads with a reasonable number of slip revolutions of the brake drum. The controls automatically adjusted the brake pedal pressure to hold this condition. The brake application cycle was set so that one brake was applied, lugging the engine the predetermined amount; then, after any required adjustment in the pedal load, the other brake was applied. After further pedal load adjustments, there was a short cooling off period before the next brake application cycle. For all testing but heat fade, this cooling off period was adjusted to hold the surface temperature of the brake drum in the temperature control band at 300 to 350 F. Under these conditions, most of the lining materials were operated under nearly optimum temperature conditions for developed friction coefficient. The temperatures were not too severe as regards wear rate.

Linings were broken-in in high gear. (This permitted an evaluation of the capacity of the lining under this condition: high rate of drum slip and low torque absorption.) Then, for the major part of the accelerated test, the tractor was operated in low gear to obtain wear data.

Air pressure was used as the source of power for applying the brakes. The engine of the D8 provided the power for the brakes to absorb. To achieve a satisfactory continuous process, the engine was not stalled, but was lugged to a predetermined speed near stall.

It should be remembered that these were essentially screening tests, and that final evaluation of the lining material was obtained under actual field conditions. The information gained from these accelerated tests was useful, however, in interpreting results from field tests. It was especially valuable because each variable which affects lining performance was tested individually, whereas field test results have to be interpreted taking into consideration many variables.

These accelerated tests are but a few of the ones carried on in our research program. Some tests can be directly evaluated in terms of field operation, while others are on a strictly comparative basis. Final evaluation of an end product, of course, lies in customer usage, but accelerated testing will help to put the best product in the customer's hands in the shortest possible period of time.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Air-Breathing Propulsion . . .

. . . can be profitably employed to reduce the ratio of initial gross weight to payload for high-altitude sounding rockets.

Digest of paper by **J. W. Luecht** Chrysler Corp.

IF the trajectory of a missile such as the well-known V-2 is given even the most casual inspection, it will be observed that a considerable fraction of the initial gross weight is burned with very little accrual of performance and under conditions quite compatible with the propositions often associated with air-breathing propulsion under the more ordinary circumstances of unaccelerated flight. The prospects of utilizing air-breathing propulsion for applications such as those represented by the V-2 would be of little interest were it not for the fact that the propellant consumption rate in ratio to thrust for a rocket is of the order of five times as great as for an air-breathing system under reasonable operating conditions. The ratio of initial gross weight to payload reaches astronomical proportions for high-impulse long-range rockets. If any place at all can be found for the utilization of air-breathing propulsion in such applications, the accompanying greater specific impulse could conceivably result ultimately in an appreciable reduction in the ratio of initial gross weight to payload.

Perhaps there are good reasons why air-breathing propulsion for such applications as this have received to date but moderate consideration. It appears at first glance that a vehicle such as a sounding rocket is in the sensible atmosphere for such a short time, it is trivial to consider utilizing the atmosphere for propulsive purposes under these circumstances. A preliminary study indicates, however, that the matter may be more than trivial.

In order to make comparisons between rocket and air-breathing propulsion as concise as possible, it is desirable to establish a simple criterion of comparison. A criterion of accomplishment at any instant of time (for a sounding rocket) should recognize both the altitude gained and the velocity gained in relation to the fraction of initial gross weight consumed. A natural criterion under these circumstances would appear to be the sum of the potential and kinetic head involved at the time in question, for this total head is a reasonably accurate measure of the maximum altitude (or range) that could be accomplished if propulsion were to cease at that instant.

It is known that, in the early portions of the flight of an upper-atmosphere sounding rocket, a very sizeable fraction of the missile mass is consumed with an accompanying increase in total head that is disappointingly small. This is shown by the "rocket" curve in Fig. 1.

As shown by the short curve marked "ramjet,"

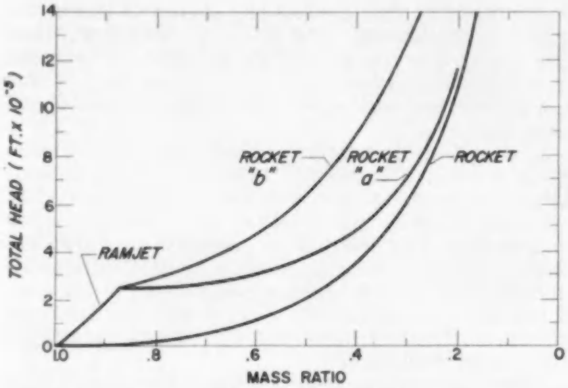


Fig. 1—Comparison of performance for ramjet boost, pure rocket, and ramjet boost followed by rocket stage (mass ratio = weight at any instant/weight at start)

the air-breathing propulsion unit is capable of producing a much greater total head for expenditure of weight than the rocket—but only up to a certain point, the magnitude of which depends upon the initial conditions in so far as initial velocity and acceleration are concerned. This limiting value of total head is not, however, at all trivial in so far as magnitude is concerned. It is of significant proportions when viewed in the light of the mass ratio to be conserved in comparison with the rocket data.

If greater total head than the limiting value of the air-breathing case is desired in any particular mission, the air-breathing stage of boost must obviously be followed by a stage or more of rocket boost. This is the obvious circumstance for the application of rocketry, namely: for propulsion outside of the sensible atmosphere. Curves for such a follow-up stage of rocket boost are illustrated in Fig. 1. An important problem in optimization appears at this point. The conditions of flight at the time of ramjet cutoff and rocket initiation are extremely important. If the ramjet is allowed to achieve its full value of maximum total head, the velocity will be zero. Under these circumstances (Case "a" in Fig. 1), most of the gains achieved by the ramjet stage will be lost by the subsequent flight during the rocket stage. In general it is much more advantageous to terminate the ramjet stage before the maximum total head potentialities of the ramjet stage have been realized, and initiate the rocket stage at a time when the vehicle velocity is still large. If this is done, very little ramjet total head is sacrificed; and very large gains are made in the subsequent conversion of mass ratio into total head by the rocket stage. The precise conditions of changeover from ramjet stage to rocket stage will depend upon the specific mission to be accomplished. Case "b" in Fig. 1 illustrates that the initial advantage to be gained by the ramjet stage can be fully preserved in the subsequent rocket stage in so far as mass ratio is concerned.

These preliminary results indicate that the prospective advantages of air-breathing boost, for even extremely high-speed ballistic missiles, is of such an order of magnitude that the ratio of gross weight to payload for any ballistic missile can be substantially reduced if and when air-breathing boost can be incorporated in such a missile.

In order to keep the problem simple, only the vehicle intended for vertical flight has been considered. This does not do the air-breathing system full justice nor does it allow the air-breathing system to show its maximum potentialities by far.

(Paper "Some Factors Pertaining to the Use of Air-Breathing Propulsion for the Acceleration of High-Altitude Sounding Rockets and Other Long-Range Ballistic Missiles" was presented at the SAE National Aeronautic Meeting, Los Angeles, Oct. 1, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Electrical Simulator . . .

. . . saves money and time in the analysis of a variety of alternate design proposals for a delta-wing aircraft.

Based on paper by **H. U. Schuerch** Aerophysics Development Corp.

COMPARISON of four methods of analyzing stresses in a delta-wing aircraft shows the electrical structures simulator is well worth its cost, especially if a large number of cases is to be investigated.

In this case the problem was, with the location of the load-carrying spars and ribs within the wing tentatively fixed, to find the cross-sectional dimensions for all these elements. The three methods compared with the electrical simulator for the solution of the problem were: actual testing of a model; wide-beam analysis (with calculations carried out on an electronic calculator); and analysis by elastic coefficients (with calculations carried out on the same electronic calculator).

1. Testing of a structural model with extensive application of strain gages. The test model had to be built before the structural layout of the actual airplane was frozen. Even though the test model was built specifically to enable structural changes,

it soon became apparent that the test results obtained would not be directly applicable. Furthermore, the delay and cost involved in building and testing the model turned out to be almost prohibitive.

Contrary to original intent, the test model finally served merely to check out analytical methods of analysis which had been developed in the meantime and which later on were applied to the actual structure.

2. Wide-beam analysis carried out with aid of a card-programmed calculator. Using the wide-beam formulas, the deformation was computed. Then a logical distribution of bending moments, shears, and torques among the spars and torque cells was derived. Card-programmed calculators solved the linear, second-order differential equations.

3. Analysis by elastic coefficients carried out with aid of a card-programmed calculator. This method, which consists of treating relaxation patterns, is a more refined method used for final stress analysis and for detail analysis of ribs and shear-transmitting fittings. The large number of simultaneous equations makes the computation a task strictly for automatic computing machines. The delta wing was analyzed by an iterative procedure performed on card-programmed calculators.

The electrical simulator used was the equipment of the Analysis Laboratory at the California Institute of Technology. It employs resistors to simulate the elastic properties of structural elements and transformers to simulate geometric properties. Voltages and currents in the electrical circuits correspond to displacements and stress distributions.

Once an equivalent network is set up and checked out, almost any conceivable question pertaining to the structural behavior of the simulated structure can be answered immediately by measuring the pertinent electrical data. Changes in cross-sectional properties can be simulated with ease by merely adjusting the variable resistors to the required equivalent values. If changes in configuration and geometrical location of structural components are to be analyzed, the corresponding nodes at the patchboard and the transformer ratios have to be adjusted.

Of course, if very large electrical networks are built up to simulate very complicated structures, the accuracy requirements for the electrical components become very severe.

Results for all four methods of analysis agreed reasonably well. Discrepancies that did occur could be accounted for on the basis of the assumptions adopted to simplify computation.

Table 1 compares the costs. The comparison is for the basic setup of one structural configuration. Also listed are the additional cost and time involved in accounting for a structural change—for instance, one due to a revised cross-section property of one element—and for analyzing one additional loading condition acting upon the same structural configuration. The comparisons are based upon the assumption that geometrical dimensions and cross-section properties of the structure as well as the loads are tabulated in suitable form to be used for the various methods of analysis. The cost and time involved in carrying out the test program are also listed for comparison of a purely experimental approach to the problem of stress analysis with theoretical methods.

From the comparative data, the superiority of the electrical simulator is obvious. This superiority becomes quite pronounced if advantage of the equipment's flexibility is taken in investigating a large variety of alternate design possibilities. This feature is most desirable in the preliminary design stages of an airplane.

(Complete paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ a copy to members; 60¢ a copy to nonmembers.)

Table 1—Comparison of Time and Costs for Analyzing Delta-Wing Stresses

		Wide Beam Formula	Elastic Coefficients Method	Electrical Simulator	Test Model
Basic Setup	Man hours	20	270	100	5770
	Machine hours	2	50	24	
	Total Cost	$140	$2350	$1700	$28,850
	Calendar Time	2 days	5 weeks	1 week	3 weeks
One Loading Condition	Man hours	4	80	2	200
	Machine hours	3	4	1	
	Total Cost	$80	$480	$60	$1000
	Calendar Time	½ day	1 week	1 hour	3 days
Change in Structural Configuration	Man hours	10	40	1	1025
	Machine hours	1	2	½	
	Total Cost	$70	$240	$30	$5125
	Calendar Time	1 day	1 week	½ hour	1 week

CRC Winds Up Chapter 2

CRC's 1951 to 1954 survey of fuel antiknock requirements of passenger cars has reached the halfway mark. The 1952 results just published show that:

- Individual makes of 1952 cars operated on primary reference fuels have a spread of 14 octane numbers in maximum octane-number requirement at the 10% satisfied point, 9 octane numbers at the 50% point, and 8 octane numbers at the 90% point.
- Octane-number requirement goes up with car age and use.
- One make of car equipped with an automatic transmission has a lower maximum requirement

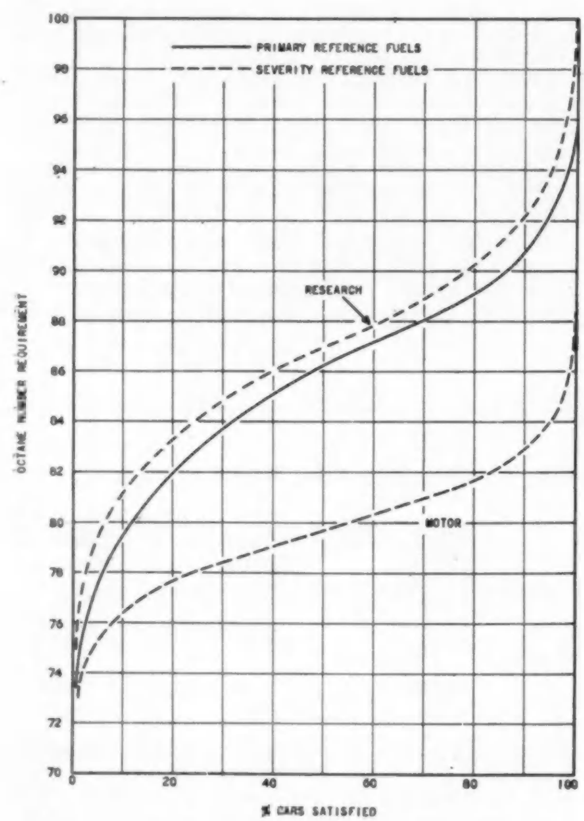


Fig. 1—Maximum octane-number requirements of 289 "new design" cars operated on primary and severity reference fuels

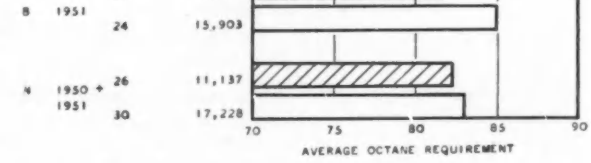


Fig. 2—This shows the effect of car age and use on average maximum requirements (primary reference fuels)

in Car Antiknock Survey

(4 octane numbers) than the same car equipped with a synchromesh transmission.

• Of four 1952 car models tested, three have higher octane-number requirements than earlier models of the same make.

• No significant differences exist in maximum octane-number requirement of cars located in the Eastern, Central, and West Coast areas of the United States.

• Ninety-seven of 303 cars tested had their maximum octane-number requirement at part throttle with either primary or severity reference fuels.

• Sixty-five per cent of 284 cars tested on tank fuels were considered to be knock-free by test observers; 69% were knock-free in the opinions of their owners.

• Twenty-one of the 303 cars tested were reported to give preignition. Of this number, thirteen were of one make.

This information is sure to be of interest to both the petroleum and the automotive industry. Best proof of this is the fact that 29 of their labs contributed the data that made the 1952 survey possible. More specifically, for the petroleum industry, the survey helps establish necessary levels of gasoline quality. For the automotive industry, it offers each company a basis for comparing its cars with those of competitors.

Altogether, the 29 laboratories submitted data on a total of 371 cars, representing 10 makes and 12

Table 1—Maximum Requirements, Independent of Throttle Opening, for 303 Cars

Car Make and Model	No. Tested	Octane Number for Indicated Per Cent Satisfied: 10% Primary Ref Fuel	10% Severity Ref Fuel Res	10% Severity Ref Fuel Motor	50% Primary Ref Fuel	50% Severity Ref Fuel Res	50% Severity Ref Fuel Motor	90% Primary Ref Fuel	90% Severity Ref Fuel Res	90% Severity Ref Fuel Motor
B	25	81	83	78	84	85	79	88	89	81
D	28	82	82	77	87	87	80	90	91	82
G-1	24	87	86	79	90	90	82	94	95	85
G-2	20	84	83	78	87	87	80	91	91	82
H	29	85	86	79	89	89	81	93	94	84
I	29	81	79	75	87	86	79	91	91	82
J	28	79	79	75	84	85	79	90	91	82
L	22	88	91	82	90	95	85	92	98	88
N	30	79	82	77	83	86	79	86	89	81
Q-A	23	74	76	74	81	82	76	86	87	80
Q-M	22	81	82	77	85	86	79	89	91	82
S	23	78	81	76	83	84	78	89	91	82

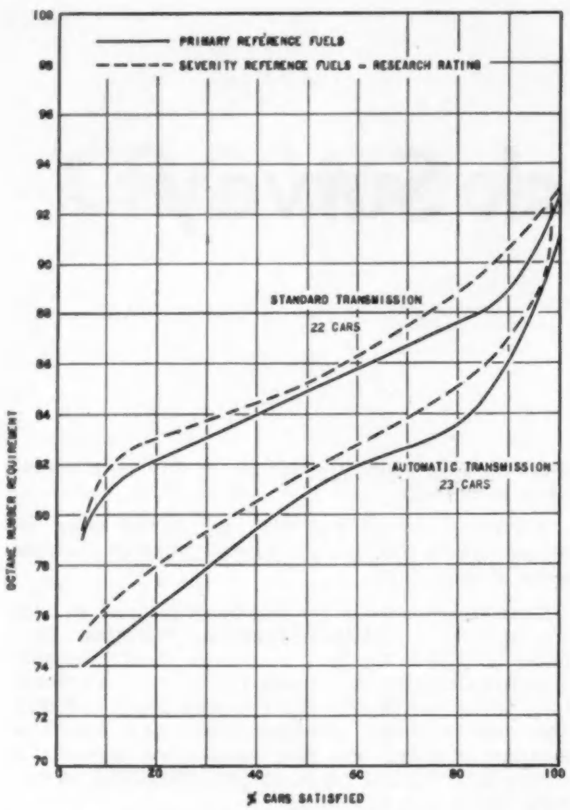


Fig. 3—Use of an automatic transmission in one make of car reduced its maximum requirement by 4 octane numbers

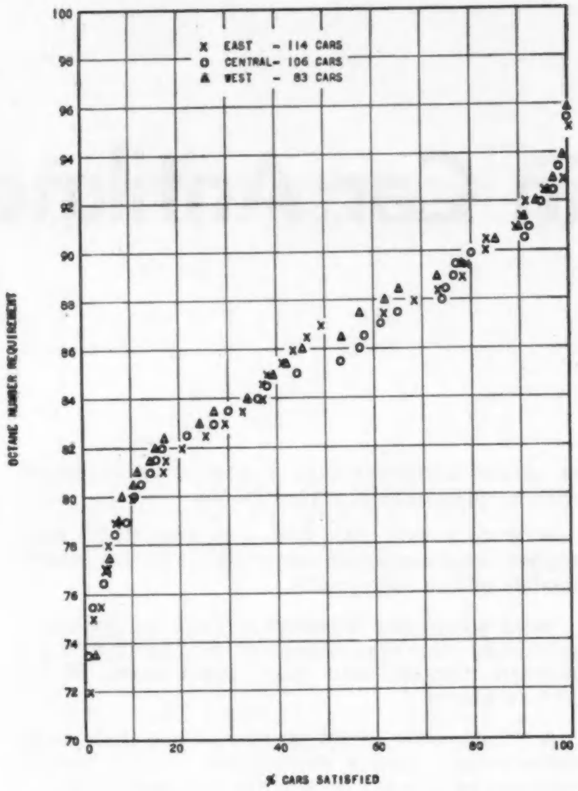


Fig. 4—The 1952 survey showed no significant differences in maximum requirements of cars located in different geographical areas of the country

models. Of the 12 models, eight were of 1952 vintage; four were 1950 or 1951 editions.

The fuels used in the survey were of two types:

Primary reference fuel blends—ASTM isooctane and n-heptane were blended in 2.5 octane-number increments to cover the range from 70 to 100 octane number.

Severity reference fuel blends—Diisobutylene, ASTM isooctane, and n-heptane were blended in 2.5 octane-number increments to cover the range of Research Method octane numbers from 75 to 100.

Octane-number requirement investigations were conducted under level-road conditions at both full and part throttle. Requirements were determined at engine speeds ranging from 750 rpm (or the lowest practical engine speed) to 2500 rpm.

Each car was also tested to determine if the engine knocked on the tank fuel. If so, the knock-in and knock-out speeds were recorded. In addition, the owner was asked:

1. What grade of gasoline was in the fuel tank.
2. Whether knock had been encountered on the tank fuel.
3. If knock had been encountered, whether it had been considered objectionable.

Now let's take a detailed look at what was found in this 1952 survey.

Maximum octane-number requirements, independent of throttle opening, for 303 Field Equipment Survey cars operated on both primary and severity reference fuels are given in Table 1. The spread in requirement between the 10% and 90% satisfied points for cars of the same make ranged from a minimum of 4 octane numbers for Car L to a maximum of 12 octane numbers for Car QA. The different car makes showed a maximum spread in requirement at the 10% satisfied point of 14 octane numbers, at the 50% point of 9 octane numbers, and at the 90% point of 8 octane numbers.

Fig. 1 shows the distribution curves of the maximum octane-number requirements of 289 "new design" cars with primary and severity reference fuels. As in the 1949 and 1951 surveys, the Research Method octane-number requirement curve for the severity reference fuels lies above the primary reference fuel curve. The maximum difference between the two curves in the range from the 10% to 90% satisfied points is less than 2 octane numbers.

Effect of age and use was investigated in four car models which were also tested in the 1951 survey. The average maximum octane-number requirements in terms of primary reference fuels and the average vehicle mileage for each group of cars are illustrated in Fig. 2. Maximum requirements obtained in 1952 were somewhat higher than those obtained in 1951. Differences varied from 0 to 2 octane numbers for Car G-1 to 3 to 4 for Car D.

Models QM and QA were tested to determine the effect of synchromesh and automatic transmissions. Car QM was equipped with a synchromesh transmission; Car QA employed a torque converter. A comparison of the distribution of maximum octane-number requirements for primary and severity reference fuels is shown in Fig. 3. Maximum requirements obtained with the torque-converter-equipped cars were about 4 octane numbers lower than those obtained on the cars equipped with synchromesh transmissions.

The effect of model changes on octane-number requirement was investigated in four makes. At the 50% satisfied point, three 1952 models indicated requirements 1 to 8 octane numbers higher than earlier models of the same make; a fourth 1952 model indicated requirements 2 octane numbers lower.

As in the 1949 and 1951 surveys, the 1952 survey showed no significant differences in requirements among cars operated in the Eastern, Central, and West Coast portions of the United States. (See Fig. 4.)

Ninety-seven of 303 cars tested were found to have maximum requirements at part throttle with either primary or severity reference fuels. See Table 2. (In the 1951 survey, 11% of the cars tested were indicated to have maximum octane-number requirement at part throttle.)

Information regarding the knocking tendencies of tank fuels was obtained on 284 cars. Of these, 204 were reported to be using premium grade fuel, 73 regular grade fuel, and 7 a mixture of premium and regular. Test observers found 65% of all cars to be knock-free, whereas 69% were knock-free in the opinion of their owners. See Table 3. (The corresponding percentages of the 448 cars tested in the 1951 survey were 63% and 64%, respectively.) Ten per cent of the owners questioned in the 1952 survey considered the knock in their cars to be objectionable.

This report was prepared by an analysis panel composed of H. J. Gibson, Ethyl Corp., leader; H. W. Best, Yale University; H. A. Bigley, Jr., Gulf Research & Development; A. E. Cleveland, Ford; W. P. Dugan, Sun Oil; J. C. Ellis, Shell Oil; G. E. Onishi, Studebaker; L. R. Henry, Standard Oil (Indiana); J. R. Landis, Research Laboratories Division, GMC; L. Raymond, Socony-Vacuum Laboratories; R. Rohde, Phillips Petroleum; L. J. Test, Atlantic Refining; and R. K. Williams, Research Laboratories Division, GMC.

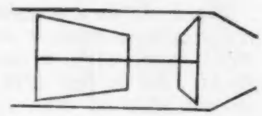
The report, "Octane Number Requirement Survey —1952," CRC-274, contains 129 pages including five tables and 43 charts. It is available from the SAE Special Publications Department. Price: $4 to members, $8 to nonmembers.

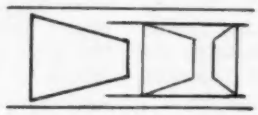
Table 2—Cars with Maximum Requirement at Part Throttle

Car Make	Number Tested	Number of Cars With Maximum Requirement at Part Throttle
B	25	0
D	28	3
G-1	24	4
G-2	20	14
H	29	9
I	29	17
J	28	13
L	22	6
N	30	0
Q-A	23	5
Q-M	22	13
S	23	13

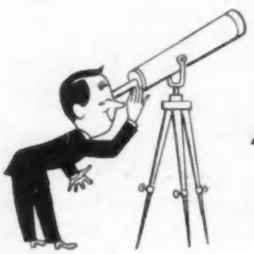
Table 3—Cars Knocking on Tank Fuel

Car Make	No. of Cars	No. Cars Knocking			% Knock-Free	
		Obs.	Owner	Objectionably by Owner	Obs.	Owner
B	25	2	3	0	92	88
D	25	7	6	2	72	76
G-1	24	12	14	7	50	42
G-2	19	4	5	0	79	74
H	26	19	16	9	27	38
I	28	9	7	1	68	75
J	24	2	3	1	92	88
L	20	15	11	6	25	45
N	29	9	6	1	69	80
Q-A	23	7	5	2	70	78
Q-M	20	11	10	1	45	50
S	21	3	2	0	86	91
Total	284	100	88	30	65	69





Ducted Fans Excel Turbojets



An Airline View

—W. C. Lawrence and H. E. Hoben, American Airlines

OUR answer to the question of turboprops or turbojets for transports is neither, for the present, unless competition forces our hand. Turbojets and turboprops don't look so attractive as ducted fans.

Our chief objections to the turbojet engine stem from its excessive cruising specific fuel consumption, its relatively low take-off thrust, and the noise which it produces at high powers near the ground. Our chief objections to the turboprop engine are its complexity of control and the noise which it produces in cruising flight within the passenger cabin.

We feel that the ducted fan—or bypass engine—is superior to either the turbojet or the turboprop on the basis of fuel consumption, power characteristics, and noise.

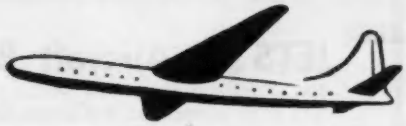
JETS, much as we like the speed and improved service they could offer, scare us with their price, their size, their appetite for fuel, and their noise.

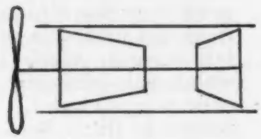
Table 1 compares costs of a jet transport with those for a DC-6. The jet is assumed to cruise at about 550 mph, at upwards of 35,000 ft. Range will be at least sufficient for a transcontinental nonstop flight—about 2500 miles against high headwinds and with adequate reserves. Wings will be swept back 30 to 35 deg. The airplanes will be powered with four of the most advanced twin-spool jet engines commercially available. These may be buried in the wing or fuselage structure—but might better be mounted in individual pods under the wings. Accommodations for at least 80 first-class passengers will be provided.

It should be noted that the direct operating costs presented in Table 1 are in cents per airplane mile. The jet airplane, of course, has much larger direct operating costs per hour than the present transport. These are in large part overcome by the higher operating speed of the jet airplane, so that certain of the per-mile costs are expected to remain about the same, or even to reduce.

Virtually the entire increase in direct operating cost is attributed to three items: fuel, oil and taxes; engine maintenance and overhaul; and depreciation of the airplane and engines. Let us hasten to say that no undue conservatism has been injected into these figures. Fuel consumption has been calculated from the engine specification without the customary 5% increase. The price of jet fuel has been estimated at 6½¢ per gal less than that of 100/130 grade aviation gasoline.

Engine maintenance and overhaul costs are in





and Turboprops for Transports

close agreement with those estimated by the engine manufacturer. Depreciation is based upon a total price of $3,500,000 per airplane, exclusive of spare equipment; fleet utilization of 8 hr per airplane per day; and a depreciation period of seven years for both airplane and engines.

If the validity of these estimates is accepted, it is obvious that the jet transport must be substantially larger in payload than the present airplane in order to have a comparable seat-mile economy. Taking a capacity of 58 passengers for the present airplane, and multiplying by the ratio of total direct costs, it appears that the jet airplane must have a capacity of about 90 to 100 passengers in order to look really attractive. This is somewhat larger than we had intended the airplane to be.

It appears, however, that a moderate increase in fuselage volume is feasible, that structure can be strengthened without too much difficulty, and that the engines will provide more thrust than had originally been counted on. Accordingly, it appears entirely practicable to expand the design to accommodate 90 to 100 first-class passengers. Such an airplane promises operating economy equal to the best we have today.

We have described a jet transport airplane which we believe can be built. It is fast and comfortable, safe and economical. What airline man is not eager to offer such an advance in service? Why are we not pounding at the factory doors, demanding early delivery of jet equipment?

There are several inhibiting factors. It must be realized that even a minimum fleet of 10 or 12 airplanes with spares and ground facilities will require an investment of about $50,000,000. At this price we cannot afford to make any serious mistake. We must be convinced that the airplane is right in design philosophy and right in detail design before any such commitment is made. Obviously, a lower price would lessen this problem.

There is an airport problem. The combination of the large payload required for economy and the very large weight of fuel required for the jet engines will necessitate take-off gross weights of 200,000 lb or more for transcontinental non-stop flights. Gross weights of 175,000 lb will frequently be required for medium-range flights. Unfortunately, many runways at major airports are marginal in length or structural strength at such gross weights.

This problem is not new, nor is it necessarily insurmountable. Runways can in many cases be extended. Structural strength is very conservatively rated—overloading may be entirely feasible. Nevertheless, we do not have a completely satisfactory answer to this problem in sight. Lower gross weight and better take-off performance would be helpful in this respect.

The matter of noise during take-off is most discouraging. Our study of the information at hand leads us to suspect that noise is an inherent quality of large turbojet engines; that it is primarily a

This feature is excerpted from the paper:

Turboprops Versus Turbojets—An Airline View

by W. C. Lawrence,
Director of Development Engineering

and H. E. Hoben,
Director of Aircraft Analysis, American Airlines, Inc.

and discussions of the paper prepared by

C. L. Johnson,
Chief Engineer, Lockheed Aircraft Corp.

George Snyder,
Chief of Preliminary Design, Boeing Airplane Co.

Carlos Wood,
Chief of Preliminary Design Section,
Douglas Aircraft Co., Inc.

Paper and discussions were presented at the SAE Southern California Section meeting held Nov. 12, 1953.

Reprints of this article collated together with the SAE Journal field editor's record of impromptu discussion are available from the SAE Special Publications Department, 29 West 39th Street, New York 18, N. Y. Price is 50¢ to SAE members and $1.00 to nonmembers.

JETS as Aircraft Builders View Them

—George Snyder, Boeing

The military airplane procurement picture is quite likely to determine what gets built. We strongly believe that the next transport airplane is going to be a commercial version of a military-type transport powered by J-57 engines. This airplane, admittedly, will be noisy, large, and expensive. But it will be economical on the long hauls. The noise is likely to restrict its use out of many airports in the beginning, but we hope and expect that over the long term, these restrictions will be lifted.

The landing field problem we don't believe is so serious. We think, for example, that with proper load distribution (that is, spreading the load on the ground) you don't have to overload airports. You can operate well within the current airport limitations.

We think that as far as runway lengths are concerned, you can design a pretty good turbojet airplane that can take off from the available air fields. It will have far superior climb performance to that which you currently have in the reciprocating-type engine. This might lead some people to think that the turbojet can actually be made safer as far as take-off hazards go.

—Carlos Wood, Douglas

Economic reasons have forced all of us into airplanes of about the same general size and characteristics. This means then that the selection of the airplane that is going to be used largely depends upon detail characteristics that make the difference between a good airplane and an outstanding one.

For example, the outstanding design must have the best cabin pressurizing system. We'd love to use direct bleed from the engines for cabin pressurization. Un-

function of the velocity of the jet exhaust itself, and that nothing short of a radical redesign of the engine to a low-velocity type will accomplish any significant noise reduction.

Unfortunately, there is evidence that four jet engines of the type and size under consideration will produce a volume of noise much greater than that produced by our present engines and propellers. There is reason to expect that annoying sound levels during take-off will affect at least twice the ground areas now involved. We doubt that the public is in a frame of mind to tolerate this increase, particularly at metropolitan airports in the Eastern section of the country. We are reluctant to be the first to put this theory to the practical test.

Our attitude toward the jet transport may change with further development or with more experience. It could conceivably change very quickly if some bold individual buys a few jet transports for operation on a competitive route. There is nothing final or irrevocable about our position. But for the present we are not eager to prematurely pioneer the jet transport. Such an attitude is fairly common among domestic airlines today.

TABLE 1—Comparative Average Direct Operating Costs

	Proposed Jet Transport, Estimated, ¢ per airplane mile	Todays' Transport Actual, ¢ per airplane mile
Flight Crew Salaries and Expenses	12.4	16.2
Fuel, Oil, and Taxes	43.4	32.6
Insurance (Personal Liability and Property Damage)	7.1	1.2
Total Flying Operations	62.9	50.3
Aircraft Maintenance and Overhaul	12.0	11.7
Engine Maintenance and Overhaul	27.8	16.5
Total Flight Equipment Maintenance Direct	39.8	29.6
Depreciation (Airframe)	35.5	12.6
Depreciation (Engines)	8.1	1.3
Total Depreciation Flight Equipment	43.6	13.9
Total Direct Flight Expense	146.3	93.8

fortunately, the engine manufacturers haven't been able to keep the oil from leaking from one part of the engine to another. So it looks like we will have to go back to mechanical superchargers. It's a shame to have to pass up all this nice high pressure hot air, but we just can't use it.

The operating costs shown for the DC-6 should be adjusted for self insurance and for low initial engine cost to be representative. The remainder of the detailed cost breakdowns are quite representative except that on the jet, we would show considerably lower engine maintenance cost. We, on the other hand, have a higher engine depreciation cost which balances us out. The net change, however, does bring the operating cost of the DC-6 and a typical jet transport closer together by about 8%.

Initial investment in a jet transport fleet would run around $50,000,000 for an airline like American Airlines. This amounts to about 40 to 50% of American Airlines net worth, which is a pretty generous gamble. I would like to point out that the manufacturer is in about the same position. By the time we take a jet transport and run it through to final CAA certification, we will have about 40 to 50% of our net worth in the program too.

By the time we continue production on the thing, and we get it to where we start to climb out of the financial hole that we dug for ourselves, we will have approximately 100% of our net worth in the project. This means that we have to be pretty careful as to what we do, and the answers have got to be good.

—C. L. Johnson, Lockheed

The fuselage-type engine installation excels the pod form only in the following regards: safety, drag, weight, performance, and aircraft controllability. Outside of that, we are for pod engines.

TURBOPROP transports of truly high speed are not within the present state of the art of transport design, we believe. Nor will they be practical within the immediately foreseeable future.

Because of limited development of turboprops by the military, little choice of powerplant is available. For the immediate future, only one specific model can be seriously considered. Fortunately, it is of a reasonable size to use in a practical four-engine transport airplane.

Because of the difference in size and thrust characteristics of the engine, the turboprop airplane will have quite different characteristics from the jet transport. Cruising speed will be much lower, about 450 mph compared with 550 mph for the jet. At this speed the wings need not be swept. Range will be no problem. Because of the improved specific fuel consumption, the transcontinental non-stop flight can be made with ease. With the better lifting characteristics of the straight wing; with reduced fuel loads made possible by the more efficient powerplant; and with the high take-off thrust provided by the propellers; such an airplane will not require unusually large airports, by present standards.

Take-off gross weights will be much lower than for the jet airplane previously described. Even with the same large payload, gross weight will be about 160,000 lb for transcontinental non-stop flights, or about 145,000 lb for flights of moderate length. Although the take-off power is about twice that of our present largest transports, it is believed that by careful propeller design the noise at take-off can be held close to present limits, with some possibility that it can even be reduced.

The direct operating costs of such a machine are undeniably more attractive than those of the jet airplane. Table 2 illustrates this point. The airplanes which are compared are carrying equal payloads for equal distances.

It will be noted that the only significant difference between the two airplanes compared is in the cost per mile of fuel, oil, and taxes. Actually, the hourly costs of the turboprop airplane are substantially lower than jet costs, but these are in large measure offset by the reduction in cruising speed.

The foregoing comparison may be surprising to some, for much greater economic advantages have commonly been claimed for the turboprop-powered airplane. The theoretical cost differential in this case has been scaled down by very practical considerations relating to the actual engines. The specific turbojet engine under consideration represents the highest state of the art in aviation gas turbine engine development to date, and further, it is scheduled for large-scale production. Consequently, its efficiency is very high for its type; and its price, because of mass-production, is rela-

tively low. The turboprop engine considered, on the other hand, is slightly obsolescent in design and will be produced only in small quantities.

Accordingly, its specific fuel consumption, as well as its price, is higher than might be expected. The use of an "ideal" turboprop engine in this study would obviously further reduce the costs of the turboprop airplane. But since no such engine will be available in the near future, we feel that such an assumption would not be valid.

Notwithstanding the small economic advantage we see for the turboprop airplane in the immediate future, it is evident that it would minimize the major operational objections listed for the jet transport. The powerplant itself introduces some new problems, however.

The propeller of the engine under consideration is directly geared to the turbine and the compressor. The engine is a single-spool axial-flow machine and will not run at low rotational speeds. Further, it will not withstand any substantial overspeed. The great precision of the speed control required over a wide range of forward speeds and engine powers has led to an intricate system of controls to co-ordinate the propeller with the engine.

In normal flight configurations the propeller is the dominant control. During landing, this function becomes too demanding for the propeller, and the dominant control becomes the engine. This leads to a very much more complex powerplant control system than those with which we have had experience. We are not entirely satisfied that it will operate with the reliability which has been characteristic of reciprocating powerplants.

Noise and vibration within the cabin have always

TURBOPROPS as Aircraft Builders View Them

—George Snyder, Boeing

We found that for long-haul operations, the T-34-powered airplane and the J-57-powered airplane have comparable economics. Now if a competing airline has the turbojet airplane, and you have the turboprop airplane, he will get all the business because his block speed will be greater. So, for long-haul operation, we don't believe that the turboprop type of airplane has a future in the transport business. Both the turboprop airplane and the turbojet airplane could, of course, be improved somewhat in their economics. The improvement would be greatest on the turboprop.

The principal problem that we see with the turbojet airplane is the airport noise problem. The turbojet noise seems to be somewhat directional. It covers in the side direction from the airport about twice the area for equal volume as present airplanes. However, directly under the path of the airplane, because the turbojet airplane tends to climb at a very high rate, noise isn't too much worse than with reciprocating engines.

—Carlos Wood, Douglas

As we study the turboprop problem further, we have uncovered a lot of very nasty problems. When an engine fails on a turboprop, there's a lot of excitement. We were worried first about the problem at low altitude, that we wouldn't be able to keep control of an airplane when it changed to a Chinese pinwheel. Well this is all right, but recently we have awakened to a problem when the engine fails at high speed with turboprop. Then the whole thing comes unglued. We don't quite know what to do about it yet, but we are working on it.

A lot more work has to be done in the airframe field as well as the engine field before we'll feel right about asking passengers to ride on a turboprop-powered transport in commercial operation.

—C. L. Johnson, Lockheed

American Airlines' cost figures are, I think, entirely fair. They represent the best study that the industry has come up with. Jet airplanes, if they're good, can equal the operating cost of the present airplanes. The turboprop airplane can equal that of the jet or can beat it by 6 to 8% for a sacrifice in speed of from 70 to 100 mph. But that 70 to 100 mph makes us stand and look a long time to see if we really want to save that 6 to 8% in operating cost.

The turbine transport problem is not one of the engineering ability of people in the United States to build such an airplane. It is a financial problem. None of us who have been in the business are foolish enough to try to make a transport airplane that cannot earn its way. That is why we won't have one for some time. But when we do, you can be sure that it will be well-engineered and that it will make money.

TABLE 2—Comparison of Turbojet and Turboprop of Same Size on 1000-Mile Flights

Estimated Costs	Turboprop Costs, ¢ per mile		Turbojet Costs, ¢ per mile
Flight Crew Salaries and Expenses	13.4		12.4
Fuel, Oil, and Taxes	28.3		43.4
Insurance (Personal Liability and Property Damage)	7.1		7.1
Total Flying Operations	48.8		62.9
Aircraft Maintenance	12.3		12.0
Engine Maintenance	30.9		27.8
Propeller Maintenance	1.1		—
Total Flight Equipment Maintenance Direct	44.3		39.8
Depreciation (Airframe)	33.2		35.5
Depreciation (Powerplants)	11.3		8.1
Total Depreciation Flight Equipment	44.5		43.6
Total Direct Flight Expense	137.6		146.3
Ratio per mile costs	1.00	to	1.06

been problems in propeller-driven airplanes. Experience, and all available information, lead us to believe that this problem will become more acute as powers and forward speeds are increased. The result, we suspect, will be a compromise in the case of the turboprop airplane under consideration. It will be difficult, if not impractical, to make the improvement in comfort which we desire.

A most important consideration in the selection of new equipment is its probable span of service. This could be quite short for the turboprop airplane in competitive service. We suspect that this airplane might almost immediately be made obsolescent for main-line routes—perhaps by a jet airplane which offered greater passenger comfort and faster schedules without increase in fare.

It could be argued that our greatest objection to the turboprop transport is its low speed; and that this could be improved if later, more advanced, and much larger engines were installed. We have considered such a design in some detail. It is theoretically possible to build such an airplane; and theoretically it would be economical. There are many difficult practical problems in such a project, however. Chief among these are questions of airplane control and stability, in view of the large destabilizing influence of the heavily loaded propellers in conjunction with swept wings. A further difficulty for which there is no presently known solution is that of suppressing cabin noise from the propellers, which would have helical tip speeds well above the speed of sound.

DUCTED FANS are a compromise between turbojets and turboprops. The ducted fan, or bypass engine, offers attractive fuel economy and large take-off thrust with only moderate noise.

By ducted fan we mean a gas turbine engine, probably a twin-spool arrangement, with a large and relatively low-compression front compressor stage. A portion of the air from this compressor bypasses the combustion chamber and turbine, and is accelerated to the rear through an annular nozzle surrounding the tail pipe.

We do not know that any engine of precisely this arrangement has ever been planned or built.

This type of engine has certain fundamental advantages compared with the true jet engine. It will be recalled that the overall efficiency of a gas turbine engine is the product of the gas generator efficiency and the propulsive efficiency. In the case of the turbojet engine, the propulsive efficiency is rather low at subsonic forward speeds because of the large amount of energy which is thrown away in the form of high jet velocity. In the case of the turboprop engine, the propulsive efficiency for the same conditions is rather high because the propeller slip stream velocity only moderately exceeds the forward speed of the airplane.

The bypass engine we have described achieves an intermediate position. The combustion jet velocity is reduced by extracting an additional increment of

energy by means of the turbine. This energy is then used to accelerate an additional quantity of secondary, or bypass, air to approximately the same reduced velocity. The result is a propulsive efficiency, and therefore a specific fuel consumption, somewhere between that of the turbojet and that of the turboprop engine. Naturally, its weight will be increased over that of a comparable jet engine, but this should be offset by reduced fuel weight.

While the basic purpose of this cycle is to decrease the specific fuel consumption of the jet engine, it has certain other most attractive characteristics. The ability to augment the basic gas generator thrust is most pronounced at low forward speeds. This means large take-off thrust, and the ability to build lighter, better-performing airplanes.

Noise produced by an air jet is roughly proportional to the cube of the jet velocity. The ability to reduce this velocity to perhaps one half the velocity produced by a jet engine during take-off should be very attractive, indeed, in a commercial powerplant.

Now as far as we know, there is no engine of this nature under active development in the United States today. We cannot understand why this should be, for it appears to us that such a powerplant of the right size would be useful not only for the military transport, but also for any strategic purpose where jet airplanes may be pressed for range. Yet it is apparent that the military have not been convinced.

While it is commonly believed that we in this country cannot afford to develop a commercial aircraft engine, our cousins over the water have no such inhibitions. Rumor has it—and all we know of this is what we read in the British press—that an engine of this general nature is under intensive development in England, by a company of very good repute. This is encouraging news, for it is likely that the bypass engine will be the key that opens the door to widespread use of the commercial jet transport, with all the advance in speed and comfort we so much desire. Perhaps this is what we are waiting for, and perhaps the wait will not be as long as one would think.

DUCTED FANS as Aircraft Builders View Them

—C. L. Johnson, Lockheed

I should say that there have been at least ten ducted fan engines designed or developed to various stages in the world, starting in 1945. The trouble with the bypass or ducted fan engines to date is that they are a single-point operation affair. The engine is quite effective at a certain Mach number, but it does not have the wide operating range required to give good overall engine performance.

That situation can be corrected, and there are design studies in this country which show that the bypass engine (I don't like to call it a "ducted fan" because the fan has something to do with a propeller and the propeller is a lot of trouble) with small diameter can be and will be a very effective engine.

Perhaps it is the best transport engine, because transport airplanes will fly for the next 15 years just under Mach 1.

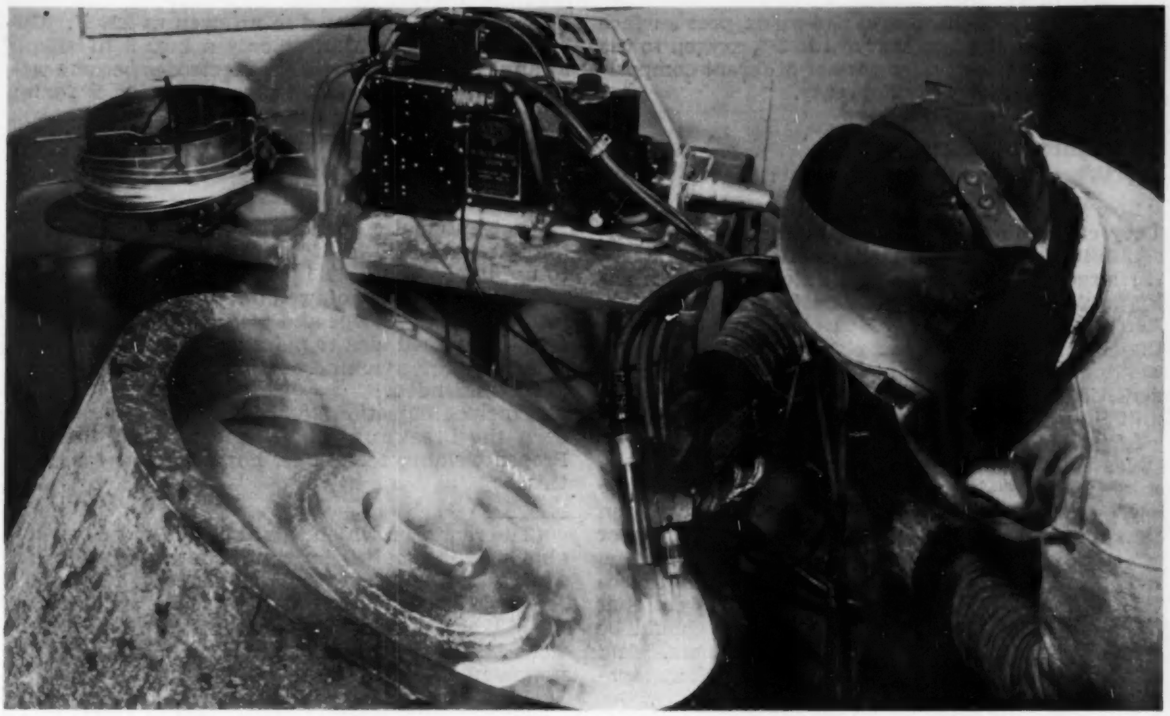
These engines can be limited in their most efficient operating Mach number range as far as the transports are concerned, but they will not have military support for a long time. The military airplanes and the bombers that use pure turbojet engines will be going so much faster than the transport that it will be hard to get military support for slower airplanes using the bypass engine.

At one time, quite a few million dollars of Air Force money went into the bypass engine, and it was given up, I think, because it did not have enough to offer in the supersonic range. That is the reason why, I think, that today there is no bypass engine in the United States.

—Carlos Wood, Douglas

We understand that one or two ducted fan engines have been built abroad. They are reported to have good economy and noise characteristics. The noise characteristics we tend to believe from some of our analyses as to the fundamental reasons for noise in jet engines. The economy we take with a grain of salt at the present time. We think, however, it shouldn't be any worse than a jet engine.

Attempts have been made to interest our own military and our own engine manufacturers in such an engine, but aside from some deep, detailed studies, not much has been done. We can hope that the situation will be rectified pretty soon. However, we should remember that engine development is not easy if you want to have one that doesn't throw parts all over the place. And development takes quite a while.



SIGMA WELDING can deposit metal four times as fast—graphic proof that . . .

New Welding Tools Rate A Chance to Show Their Stuff!

Quentin Ingerson, Ampco Metal, Inc.

Based on secretary's report of Panel on Welding held as part of the Milwaukee Production Forum, Sept. 14, 1953.

NEW welding equipment and materials now on the market can solve many current welding problems. They can also cut present fabrication costs and reduce the time required per job. But they can't do these things unless—and until—they're given the opportunity! Overcoming management resistance to try out these innovations and to provide adequate employee training programs—once tried—is the toughest problem the welding industry faces today.

Metal Deposited Four Times As Fast with Sigma Welding

With sigma or inert-gas welding, for example, it's possible to deposit metal at the rate of 30 to 40 lb per hr (compared to only 10 lb per hr with other methods). What's more, this relatively new method of welding can be used for both ferrous and nonferrous applications.

Sigma welding does, it is true, present some prob-

lems (porosity, inclusions in the welds, poor surface appearance). But addition of 1 to 3% oxygen to the inert gas and use of filler wire of different compositions have improved weld quality.

Low Hydrogen Electrodes Put Whammy on Cracking

Low hydrogen electrodes, too, have a lot to offer. They can reduce to a minimum the cracking susceptibility of (1) welds made on high sulfur steels, (2) large sections where high internal stresses exist, and where carbon content is varied or high. And while these low hydrogen electrodes cost more than common commercial electrodes, they do save welding man-hours. That's because higher current densities can be employed, hence weld deposits per unit time can be greater.

Low hydrogen electrodes lead to less cracking because they strike a mortal blow at one of the big troublemakers—hydrogen embrittlement. They don't supply the damaging amounts of hydrogen that most commercial electrodes do in one way or another.

The low hydrogen content of these special electrodes, however, can be maintained only by proper handling and storage. The electrodes should be purchased in hermetically sealed containers. And after the seal of a container has been broken, storage should be continued in an oven at 250 F. Operators should be allowed only a 2 to 3 hr supply at any one time. Should the electrodes become wet, baking them in a vented furnace at 500 F for an hour will remove the moisture.

Submerged Arc Welding Has Unlimited Possibilities

Semi-automatic submerged arc welding has unlimited possibilities—if operators can be induced to use it.

But if this type of welding is to be a success, proper welding fit ups and techniques are essential. It is also a good idea to place amperage and voltage tables on the machine. A 3/32 in. diameter wire is recommended.

Principal objection to this welding process has been the breakthrough of the arc from the flux. Proper welding technique, however, can overcome this.

(The report on which this article is based is available in full in multilithographed form together with reports of the other six panel sessions held at the Milwaukee Production Forum. This publication, SP-303, can be obtained from SAE Special Publications Department. Price: $1.50 to members, $3 to nonmembers.)

Facts You'll Want to Add to Your Warehouse of Welding Wisdom

- A perfect weld is not a must on all jobs. Many times porosity and poor surfaces can be tolerated.
- Preheating temperature of cast iron prior to welding should not exceed 1100 F. At temperatures of 1150 to 1200 F, the ultimate strength of an iron can be decreased from 40,000 psi to 26,000 psi. Dimensional stability is also affected.
- Flame cutting of high tensile steels causes high hardnesses and longitudinal cracks. To overcome this problem, use a preheat torch prior to cutting. Double cutting, wherein the first cut is usually on the scrap side, is also recommended.
- Resistance welding is being succesfully used for cast-iron pipe butt weldments. To get good results, it is necessary to have good electrical contact, rotate the pieces during heating, and apply pressure on the butt ends at the proper time. Annealing is required to take care of hard zones which occur at the weld.
- Salvage welding of cast iron won't be a success unless dirt, oil, and other injurious materials are thoroughly removed.

What New Welding Tools Can Do

. . . (as described in the adjoining article) was aptly explained by this panel of welding experts:

J. J. Chyle, Panel Leader
Director of Welding Research
A. O. Smith Co.

Q. Ingerson, Panel Secretary
Metallurgist
Ampco Metal, Inc.

I. R. Bartter
President
Automatic Welding Co.

M. Hippe
Sales Representative
Linde Air Products Division
Union Carbide and Carbon Corp.

Carl Zilch
Chief Metallurgist
Bucyrus-Erie Co.

Peter Stern
Welding Engineer
Heil Co.

Willard Schumbacher
Welding Engineer
Allis-Chalmers Manufacturing Co.

J. Franzreb
Metallurgist
J. D. Adams Co.

L. Higgins, Ladish Co.
E. J. Borisch, Milwaukee Gear Co.

Based on secretaries' reports of Panels on Gears (Borisch) and Heat Treating (Higgins) held as part of the Production Forum at the SAE National Tractor Meeting, Milwaukee, Sept. 14, 1953.

Gear-Making Tips

Did you know that . . . ?

In Designing Gears . . .

Gears with wide faces should have large crowned teeth. Designing them this way helps to eliminate noise and allow for distortion.

In the Gear Material Area . . .

The swing is away from boron steels. There is a tendency to go back to 8600 and 8700 series steels as they become available. Of these grades, 8722 is most frequently used for heavy sections, 8620 for light ones. Where increased hardenability is desired, 8722 is sometimes being used with an increased molybdenum content of 0.30 to 0.40%.

Main difficulty being encountered with boron steels is non-uniform hardenability of different heats. This leads to distortion, especially in light sections. One way to cope with this problem is to make trial runs on pilot lots. Characteristics of the steel can thus be determined, and necessary corrections made before the steel is put into full-scale production. Another approach is to set up specifications that limit the hardenability of boron steels to narrower ranges.

Machining is a problem with 94B15 boron steel, particularly when its carbon content is low (0.12 to 0.14%).

In Heat-Treating . . .

Most distortion in gear teeth occurs because the rough forging did not receive the proper heat-treatment prior to machining. One good heat-treating rule is to use as long a cycle as possible to condition (unify) grain structure. Using the gas carburizing method instead of box carburizing will likewise do much to hold distortion to a minimum. So will holding the quenching out temperature constant. When using a Gleason quenching press, it's important not to restrict oil flow . . . and be sure that the top face of the die is in contact all around the face of the gear.

Less distortion usually results with induction hardening than with gas carburizing. (This is probably due to a smaller zone being heated with induction hardening.) The best way to handle the tendency of gear teeth to "grow" when hardened by induction is to compensate for such growth in the machining operation.

When carburizing gears, cooling and reheating before quenching has two advantages over direct quenching: (1) better control over distortion, and (2) better hardness and carbon concentration control.

A very simple way to keep the bore of gears soft during gas carburizing is to string the gears on a black iron pipe which has holes in it and is filled with forging scale. There is also a mixture of fire clay and forging scale on the market which provides

The Men with the Prescriptions

. . . for the gear-making ills outlined in this article were:

Gears

E. A. Hunt, Panel Leader
Massey-Harris Co., Inc.

E. J. Borisch, Panel Secretary
Milwaukee Gear Co.

F. H. Boor
Wisconsin Axle Division
Timken-Detroit Axle Co.

G. C. Collins
Clark Equipment Co.

C. Tohn
Caterpillar Tractor Co.

Heat Treating

J. E. Schoen, Panel Leader
Marquette University

L. Higgins, Panel Secretary
Ladish Co.

G. B. Kiner
International Harvester Co.

J. Byerstead
Nordberg Manufacturing Co.

V. Erickson
American Steel Treating Co.

J. F. Klement
Ampco Metal, Inc.

Dale Wright
Caterpillar Tractor Co.

effective protection for selective carburizing. Copper-base paints offer fair protection.

Four things can be done to guard against decarburized surfaces: (1) check carburizing furnace for CO and CO_2 content, (2) be sure that the atmosphere is of sufficient concentration, (3) make certain that all the gears get heat . . . and that each gear is completely immersed in the atmosphere, (4) see to it that gears are clean when they go into the furnace. The two best methods for removing decarb are shot blasting, and copper plating and rehardening.

As far as heat-treatment is concerned, the most important part of a tooth shape is the fillet. It should be made as large as practical to cut down stress points in the tooth.

In General . . .

● Hard spots in forgings are the result of too rapid cooling which causes pearlite to change into martensite.

● Shotpeening is necessary where austenitic structure is present in gear teeth. Shotpeening cold works the surface and breaks up the continuity of tool marks, thus increasing life and strength of the teeth.

● Cyaniding is being used less and less because of the slowness of the process and the poor working conditions involved.

● Core hardness of gear teeth should be kept below 38 R_c at the center of teeth (on the pitch line). If hardness exceeds this, you can expect trouble. Core hardness of 25 to 35 R_c will give best results.

● Gears are only as good as their mounting. Poor mounting often causes gear noise and leads to premature failure. Crown shaving gears allows for some inaccuracy in the mounting.

● Gear shaving should not be used as a means for correcting gears inaccurately hobbed. To avoid cold working, gear shaving cutters should be kept as sharp as possible.

(The reports on which this article is based are available in full in multilithographed form together with reports of the five other panel sessions of the 1953 SAE Tractor Production Forum. This publication, SP-303, can be obtained from the SAE Special Publications Department. Price: $1.50 to members, $3 to nonmembers.)

Aviation Gas Supply Can Now Be Expanded Fast!

Com. D. L. Nowell, Navy Bureau of Aeronautics

Based on paper "The Armed Services-Industry Cooperative Study of Aircraft Fuel Rating Methods" presented at SAE National Aeronautic Meeting, Los Angeles, Oct. 2, 1953.

THIS country is now in a position to act quickly and intelligently when a national emergency requires rapid expansion of aviation gasoline production. Work by the Armed Services-Industry Group on Aircraft Fuel Rating Methods helped do the trick.

This group developed a technique which takes a lot of the guesswork out of establishing safe power settings for aircraft engines using alkylate-substitute fuels. Thanks to charts prepared by ASI, it will now be possible to use these higher sensitivity fuels without decreasing the safety margin of engines whose performance limits have been established for alkylate fuels.

Therefore, the unavailability of sufficient alkylation plants in a national emergency won't be the problem it once was. No longer need alkylate-substitute fuels cause engine trouble. Hence, no longer need aviation fuel be in scarce supply in an emergency due to lack of ample alkylation facilities.

Experience in World War II showed that two things had to be done if substitute fuels were to augment aviation gasoline production:

1. The spread between the mild and severe laboratory test requirements that controls the antiknock properties of fuels had to be increased to accommodate the more sensitive substitute fuels.
2. The operating limits of aircraft engines had to be re-established at levels for high-temperature operation that would avoid unsafe conditions when using substitute fuels.

Thus, for each change in fuel test requirements, it was necessary to develop a new schedule of permissible aircraft power settings for different inlet severity conditions (rpm and carburetor air temperature). But much operating difficulty was experienced on making these adjustments. That's because they were sometimes based on incredibly sketchy data.

This is where the charts developed by ASI come in. They relate the knock-limited performance of aircraft engines to the laboratory test requirements

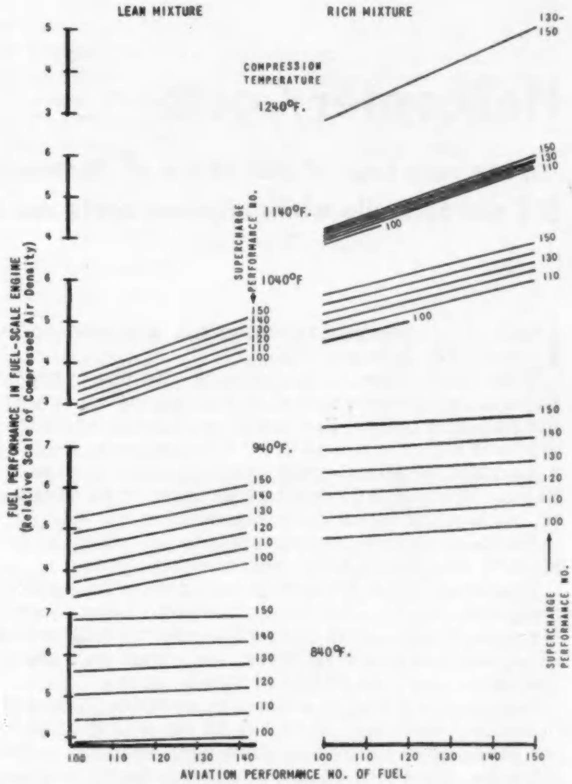


Fig. 1—Charts such as this are expected to take a lot of the guesswork out of establishing safe power settings for aircraft engines using alkylate-substitute fuels. That's because they relate the knock-limited performance of aircraft engines with the laboratory test characteristics of a fuel

of a fuel. (These antiknock characteristics were found to be adequately defined by a joint combination of Aviation and Supercharge ratings.)

Fig. 1 is an example of the type of correlation chart that was developed. Note how reliably the two ratings (Aviation and Supercharge) express the full-scale performance limits without regard to the type of fuel being evaluated.

In this chart, an increase in the charge temperature causes the slope of the lines (which represents the significance of the Aviation rating) to increase. Simultaneously, the spread between the lines of different Supercharge rating decreases, indicating a decreasing influence of that rating on aircraft performance. Thus at a very high mixture temperature, the correlation is almost entirely controlled by the Aviation value. On the other hand, at a very low mixture temperature, the Aviation rating has almost no effect, having been displaced by the Supercharge value.

Actually, however, the fuel antiknock requirements of a given model of engine cannot be expressed in terms of a permanent pair of Aviation and Supercharge ratings. This is because the same engine model is usually installed in a wide range of airframes. And conditions of engine operation are varied as found necessary to achieve short range at high speed, long range at high payload, and so forth. Thus a knowledge of military plans is required to be able to settle on the fuel that is needed. Obviously, this is a changing pattern that could not be foreseen by ASI. Furthermore, the military fuel requirement destination must be coordinated with a knowledge of industry fuel production facilities—still another changing pattern.

Consequently, ASI considered its assignment complete when it had demonstrated a technique whereby the relation between fuel antiknock characteristics and aircraft engine performance can be used to make adjustments when necessary.

It is recommended that the correlation charts which express this relation be used by those who possess the additional information required to coordinate military aircraft plans with fuel production plans. Likewise, it is recommended that Aviation and Supercharge specification requirements be continued as the means for coordinating the permissible aircraft performance limits and the required fuel characteristics.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Helicopter Costs . . .

. . . are very high at this stage of its development. Helicopter operations cost around $17 per ton-mile while airplane costs are only about 25 cents per ton-mile.

Based on talk by **C. M. Belinn,** President, Los Angeles Airways, Inc.

JUST about everything connected with helicopter operation is expensive.

Take maintenance, for example. No one operates enough helicopters to put maintenance on a production-line basis. But there are many, many operations which must be done frequently on each of a handful of ships. The rotor head is a case in point. There are 65 points that have to be greased on each rotor head assembly after every trip.

Costs on future helicopters will be lower if designers can provide for less maintenance.

Operators hope that they can design less costly components, too. Currently, the rotor head assembly on our helicopters costs $750. Worse still, it has to be replaced every 100 flying hr. That unit alone, therefore, costs us $7.50 per flying hour.

Progress in reducing costs is being made, however. Operating costs on our first S-51 amounted to $1.65 per mile. This figure has since been reduced to 68¢ per mile. On certain rotors, a new adhesive enables blades to go 1000 hr, which is a considerable improvement over earlier blades.

What could be more costly to the helicopter industry than any of their present expenses is a catastrophic crash. Rather than take this risk, we should proceed cautiously. Los Angeles Airways has accumulated over 100 hr of experimental instrument flying in hooded cockpits, but we restrict operational flying to periods of good visibility.

Our 30,000 hr of operation have taught us that clear-weather operations can be conducted on a 100% basis.

During a 30-day period last September we conducted 81% of our scheduled operations, despite the fact that the weather was somewhat adverse.

As costs come down, it will be economically worth while to establish metropolitan-type helicopter operations in more cities. There are perhaps two dozen areas which could sustain helicopter services like those now operating in Los Angeles, Chicago, and New York.

This is perhaps the optimum use for the helicopter. It is well suited to shuttling mail between downtown post offices and outlying airports and to shuttling passengers between terminals and airports.

Someday helicopters may enter local airline service and even take over for intercity buses. But costs will have to drop a long way before that day comes.

(Based on paper "Helicopter Passenger Progress" was presented at the SAE National Aeronautic Meeting, Los Angeles, Oct. 2, 1953.)

Electrical Equipment . . .

. . . for trucks is going through a design metamorphosis as tougher electrical demands are imposed by diesel engines, higher compression ratios, and radio and TV interference.

Based on paper by **J. H. Bolles** General Motors Corp.

EVEN two passenger-car motors aren't enough to crank a diesel engine. It is necessary to use a much larger motor because of the horsepower required to spin a diesel fast enough to reach firing speed.

A 330 cu in. passenger-car engine with starting-motor pinion to flywheel ratio of about 18 to 1 will require a cranking speed of 35 to 40 rpm at 0 F to fire the engine. The horsepower requirement is 1.2. A comparable cubic inch displacement diesel requires a cranking speed of 120 to 150 rpm at 0 F. About 4 hp is required. Therefore, a diesel starting motor must be designed to produce the necessary torque at the required high speed. Large batteries must be used to provide the power. The gear ratio between starting-motor pinion and ring gear is about 10 to 1, which is needed to get the high cranking speed.

A passenger car 12-v starting motor is designed to produce the maximum watts output with an input of 250 amp. The running torque at this point is 5 lb-ft. A diesel 12-v starting motor, on the other hand, produces its maximum watts output at 600 amp and the running torque is 17 lb-ft.

On over-highway trucks having electrical loads of about 35 amp, a 50-amp d-c generator, properly installed, will give satisfactory service for at least 100,000 miles. Here, d-c equipment is cheaper than a-c and is easier to maintain. Where output is required at very low speeds as well as very high speeds, the a-c alternator is more suitable as it does not have to contend with the commutation troubles which might exist with d-c equipment. On buses equipped with fluourescent lights, the a-c equipment is definitely advantageous.

On all new designs of regulators for heavy-duty work, external adjustment is incorporated so that a limited amount of adjustment can be made without removing the cover.

Twelve-volt equipment is highly desirable on 8-cyl engines having a compression ratio over 8:1 and construction such that free breathing is obtained at high speeds. The 12-v system affords a larger safety factor between voltage required by the engine and voltage available from the ignition coil. This permits more mileage with plugs before cleaning and resetting and eliminates some missing of slightly fouled plugs.

Passenger-car electrical loads have been increasing steadily. To handle these heavier loads, smaller size wires can be used with 12 v than with 6 v, thus reducing the wiring harness cost. About 30% more watts can be had from 12 v than from 6 v. The truck industry can get some advantage from the high production tooling of the 12-v passenger-car equipment.

The government may try to control radio and television interference, hence it might be desirable for the truck industry to suppress its vehicles and thereby avoid control. There are four satisfactory methods:

1. Suppressors at plugs and ignition distributor towers.
2. Bypass condenser at ignition coil.
3. Condensers at generator and regulator of charging circuit.
4. Shielded leads between generator and regulator.

(Paper "Motor Truck Electrical Equipment" was presented at SAE National Transportation Meeting, Chicago, Nov. 4, 1953, It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Based on Discussion

A. D. Gilchrist
The Leece-Neville Co.

High horsepower is needed to crank diesels at speeds equal to or about 150 rpm. The newer design diesels are requiring speeds as high as 300 rpm. This presents a challenge to the accessory engineer with the present limitation of size and weight for cranking motors.

We find two main advantages with air cranking units. First: the increase in horsepower output with increase in pressure and the ability of air tanks to withstand relatively high pressures compared to the single voltage available from a given battery. Low speed cranking at 100 psi pressure may be corrected without any change other than to charge the tanks to 150 psi. Second: the ability of air cranking systems to deliver the same power at very low temperatures while the electro-chemical limitation of batteries may reduce motor output to a value too low to start an engine.

Our experience shows the need for load and generator system analyses beyond the ratio of 75% between generator current rating and the total load amperes. Watt hour or ampere hour calculations may include transient loads and the very important generator idle output. This data will make the choice between d-c or combined a-c and d-c systems reliable and easy.

Recipe for Standard

Easy to State . . .

B. B. Johannsen, John Deere Plow Works, Deere and Co.

Based on paper "Tractor Hitches and Hydraulic Systems—An Implement Designer's Viewpoint" presented at SAE National Tractor Meeting, Milwaukee, Sept. 17, 1953.

THE ingredients that are needed to make integral hitches better can be summed up in just two words—more versatility. For while integral implements have got drawn implements beat in many ways, (see box) they'd be even better if tractor hitches and hydraulic systems more nearly met field requirements. Tractor hitch dimensions need to be standardized so that one make of integral implement will operate successfully with all makes and models of tractors . . . and vice versa. As for hydraulic systems, what's needed is a control that will satisfactorily operate a wide variety of implements instead of just a limited few.

The only way to accomplish these ends is for tractor and implement designers to get together and discuss their individual and mutual problems. Here's what an implement designer believes should come out of these sessions.

To make integral equipment more acceptable, the following features should be incorporated in the design of implement hitch and hydraulic systems:

- Implement interchangeability on competitive tractors . . . and tractor interchangeability on competitive implements.
- Quick and easy attachment of implements.
- Simple and easy-to-adjust hitches.
- Means for fore-and-aft, and lateral leveling of an implement.
- Provision for side sway of implement where required.
- Adequte lifting capacity in hydraulic system.
- Means for depth control of implement.
- Hitch should maintain implement in proper relationship to ground.
- Provision for remote hydraulic cylinder.
- Satisfactory tractor longitudinal stability.

Interchangeability

Already standardization activities of SAE and ASAE have established dimensional relationships that permit interchangeability of competitive tractors and drawn implements. Now it appears desirable to secure the same interchangeability for integral implements using a common hitch.

To accomplish this, tractor manufacturers should make available the following information:

1. Dimensional relationship of points of implement attachment.
2. Arc of travel provided at points of implement attachment by the tractor hydraulic system.
3. Precautions that implement manufacturers must take to secure proper functioning of the depth control means provided in the hitch.
4. Loads that can be safely applied to the hitch.

Easy Attachment

A design which enables one man to attach an integral implement to a tractor quickly and easily is certainly a necessity. In this regard, integral implements on the market today are generally more difficult to attach or detach than corresponding drawn tools. Thus, wherever possible, quick attachable features should be incorporated in integral hitches.

Simple, Easy-to-Adjust Hitches

Hitch adjusting members should be readily accessible and easy to adjust without the aid of special wrenches. They should also be so positioned that the amount and direction of adjustment needed is readily detected. To reduce operator confusion, the number of adjusting members should be held to a minimum.

Means for Fore-and-Aft and Lateral Leveling

Most tillage tools require a relatively close relationship between the angle of the implement and the soil. This relationship is normally established by adjusting the length of the top link, which, on some hitches, is also a means of depth control.

Fore-and-aft leveling is required to take care of

turn to page 69

Tractor Hitches

. . . But Tough to Follow

Harold L. Brock, Ford Motor Co.

Based on paper "Tractor Hitches and Hydraulic Systems—A Tractor Designer's Viewpoint" presented at SAE National Tractor Meeting, Milwaukee, Sept. 17, 1953.

THE recipe for a standard tractor hitch may be easy to concoct, but it isn't so easy to follow. For while the hitch and hydraulic system are but two of the many components that make up a tractor, they dictate the general design of the whole vehicle!

Because this is the case, it might prove interesting to discuss some of the tractor design considerations that must be recognized when using the following types of hitch:

- Front integral hitch.
- Towed implement hitch.
- Rear integral hitch.

Front-End Must Be Tailored for Front Hitch

Let's first consider the effect on chassis design of a front hitch.

To permit an adequate stroke of front-mounted implements, the front of the chassis of a tricycle-type tractor may have to be raised as much as 10 in. This, in turn, not only introduces a stability problem, but it also presents seat-access and seating-comfort problems.

To regain the longitudinal stability lost as a result of raising the tractor center of gravity, it is necessary to increase the wheelbase or mount heavy weights on the front when operating with rear equipment. Lateral stability of the tractor, however, is seriously decreased by the higher center of gravity and the reduced horizontal distance between this center of mass and the ground contact line connecting the points of supports of the outer wheels.

At the same time, the increased height of the tricycle tractor introduces problems in providing easy access to the driver's seat and furnishing adequate seating comfort. With front-mounted equipment, it often requires a contortionist to climb over the necessary linkage or hydraulic lines. What's more, for every inch the seat is raised above the ground line, a proportional increase is brought about in the lateral and longitudinal motion of the operator when operating over rough terrain. Thus the problem of seating requires greater attention with a front hitch.

Now that consideration has been given to the effects of raising the tractor, it would be well to

Why Farmers Are Enamored of Integral Implements

Since World War II, farmers have been taking more and more to integral implements. This ever-increasing popularity of integral implements over towed ones can be attributed to:

- **Greater maneuverability—with integral implements, a farmer can work small or irregularly shaped fields that are impossible or impractical to work with drawn implements.**
- **Better transporting characteristics—integral implements can be transported at higher speeds over hard-surfaced roads than drawn implements.**
- **Lower cost—integral implements usually are cheaper than towed ones. This is because wheels, raising and lowering mechanisms, lateral and longitudinal adjustments, and depth-gaging means are furnished as part of the tractor.**

examine some of the operational problems with the resulting pedestal-type front structure.

To provide sufficient clearance for implements, the wheels must be tucked within the confines of the chassis, thereby making it impossible, in most cases, for the operator to see what he is running over. This often results in serious damage to the front mechanism.

At the same time, the possibilities of bogging down and locking the front wheels due to soil pickup are increased. For when wheels are spread apart, they seldom become immobilized at the same time.

Having examined some of the problems a tractor chassis engineer faces in providing a suitable vehicle for mounting a front hitch, let's see how such a hitch affects the implement controls engineer. His big problem is providing the controls and hitch for the front unit at no extra cost (above that required for the rear unit).

To make matters worse, the implement engineer designs many implements so that portions are mounted on the front as well as the rear. In doing this, the implement engineer has, in most cases, doubled everyone's problems. He must design a double structure for his soil working tools; the tractor engineer must design dual controls; the manufacturer must double his tooling; and sales people must convince the public that the combination is worth twice as much.

Towed Hitches Call for Heavier Tractors

A towed implement hitch has a somewhat different, but equally strong, influence on tractor design. It requires that the tractor be much heavier to provide draft without excessive wheel slippage. To be more specific, a comparison of tractors in the full 2-bottom plow class shows additional built-in weight in excess of 1000 lb for units trailing plows.

The most serious consequence of this extra tractor weight is its adverse effect upon flotation and soil compaction. A further objection is the need for more power to propel it.

Rear Integral Hitch Dictates Tractor Design

With a rear integral hitch, a tractor engineer must design still a different creature. To fulfill the requirements of the various integral implements and equipment, he must incorporate the following features in the tractor:

1. A hydraulic system that provides control both by draft reaction and by selective positioning of the tools in relation to the chassis. Furthermore, the system should be able to add additional remote circuits for operating both single-acting and double-acting cylinders.

2. A hitch that provides ample support without requiring excessive framework to stabilize the implement.

3. A hitch that provides for longitudinal and lateral adjustments. It should also permit lateral movement for contour work—and provide a means for immobilizing this motion.

4. A hitch that provides implement trailing characteristics which follow the direction of steering and stabilize the implement on hillsides.

5. A linkage that approaches a parallelogram in the vertical plane (to minimize the effect of overhung implements on hydraulic lifting capacity).

6. An overall system that restricts motion of the implement in the transport position (to reduce damage to the tractor and equipment when operating over rough surfaces at high speeds).

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Excerpts from Discussion by

Thomas Evans

Minneapolis-Moline Co.

• There can be no standard hitch or hydraulic system until the problems of hitching and controlling larger mounted implements (both tillage tools and harvesting equipment) are solved.

Clarence A. Hubert

International Harvester Co.

• The complex hydraulic systems and other new developments which we will see in the next few years must not be considered solely in the light of engineering achievements. They must be evaluated coldly on a dollars-and-cents basis, too. Very little will have been gained if the farmer cannot mount such machines as corn and cotton pickers and thereby increase the revenue he receives from a tractor.

• The farmer is no longer plagued with fears of machine shortages. As a result, he may ultimately demand a standard arrangement of implements and tractors, despite conflicting theories and arguments of professional engineers.

George M. Eveleth

J. I. Case Co.

• Farm machinery manufacturers should try to provide a more suitable front cultivator mounting —one which will permit a cultivator to be attached or detached as quickly as present rear-mounted equipment.

• I believe the author has overemphasized the loss of longitudinal and lateral stability of tractors designed to accommodate front-mounted cultivators. In my opinion, he has exaggerated the need for raising the tractor center of gravity.

• There's a need for a hitch connection and plow assembly that will give a fairly uniform plow-cut width with both straight-furrow and contour-furrow operation.

• I am not a supporter of draft control. In my opinion, it is merely a means of "short changing" the working depth of the implement to permit the tractor to continue operating without shifting to a lower speed.

• An agricultural tractor is not complete if it

doesn't have a means for adding remote circuits for actuating remote hydraulic cylinders.

Igor Kamlukin
Allis-Chalmers Mfg. Co.

- The solution to the tractor stability problem with front-mounted equipment is not as great as intimated by the author. A tractor designed for front-mounted equipment must have sufficient wheelbase to permit cultivating equipment to be placed behind the front and rear wheels. This, in turn, moves the center of gravity forward of the rear wheels, giving increased longitudinal stability. Also, the increased length permits placement of the fuel tank and battery behind the engine, thus helping to keep the center of gravity low. Final drives with smaller tires are still another means of keeping the center of gravity down and, at the same time, providing ample crop clearance.

- The increased popularity of the adjustable front axle does not mean that the tricycle tractor is on the way out. Equipment like mounted cornpickers need the clearance that is blocked by the wide axle.

- The need for easy adjustment of rear wheel treads is more important with mounted equipment. This is because, in effect, the rear wheels of the tractor become the wheels of the implement.

- Demonstrations showing how fast one can attach different implements are meaningless unless preparation of the whole tractor to work these implements is also a simple and quick operation.

- We have not found it practical to control such tools as plows, bedders, and field cultivators with a selective positioning control. Up and down variations of the tractor change the position of the implement in the ground too much. We limit the use of positional control to operations where the important consideration is maintaining the position of one member with respect to another.

Easy to State . . . continued from page 66

manufacturing variation in implement and tractor parts, differences in rolling radii of pneumatic tires, and variations in size and type of tractor tires. Furthermore, a readily adjustable upper link promotes easy attaching of an implement to a tractor.

Provision for lateral adjustment of an implement is also necessary. This type of adjustment accounts for manufacturing variations and the operating condition wherein one wheel of the tractor must operate in a furrow for some implements and on level ground for others.

Provision for Side Sway of Implement

To secure the desired trailing characteristic of such tillage tools as plows and tillers, provision should be made for the tool to follow the tractor around contours without adversely affecting tractor steering.

With this in mind, it appears that the best position for the hitch point is near the rear axle on the centerline of the tractor. This would be a compromise between hillside and contour plowing from the standpoint of controlling width of cut. Also, there would be no effect on steering from either an offset line of draft or from the tendency of a plow to rotate in a horizontal plane.

Some implements, however, (bedders, planters, scoops, and some types of cultivators) need to be locked to the tractor to prevent sidewise movement. Therefore, it must be possible to lock the side sway linkage.

Provision for this is important for another reason. Implements can be transported better if sway is restricted.

Adequate Hydraulic-System Lifting Capacity

The lifting capacity of the hydraulic system in most tractors has been developed over the years to meet the requirements of implements in general use. Formerly, however, the hydraulic system of a tractor was used only for raising and lowering implements, not to adjust their working depth. When a hydraulic system is used for depth adjustment as well, capacity must be added for this purpose.

Means for Depth Control

The problems of depth control and depth adjustment—and the means for providing these functions—are by far the most difficult of the entire hitch program.

Some implements (planters, rotary hoes, and spiketooth harrows) are more or less self-gaging as regards depth control, and therefore pose no particular problem. Moldboard plows, disk plows, listers, subsoilers, and cultivators do, however, require depth gaging means. However, since operating characteristics of these tools differ, it is difficult to establish one means of depth control that will apply to all.

In general, five basic methods of depth control are now used with integral tools:

1. Suspension of the implement—With this method, the implement is lowered to the desired working

depth by the hydraulic system and suspended from the tractor in this position. The tractor wheels then become the gaging points.

This is the simplest method from a mechanical standpoint, but it has several disadvantages. It is not easy to control the working depth of a rear-mounted tillage tool over uneven terrain; with a suspended implement the problem grows. As a tractor is driven over uneven ground, the working depth of the implement varies. If the tractor is operated through a swale, the implement will have a tendency to go deep and, conversely, if the tractor goes over a hill the implement will tend to come out of the ground.

2. Independent depth-gaging means provided on the implement—This method of depth control is identical to that employed successfully on drawn implements. However, when applied to integral implements, simplicity and economic advantage are sacrificed. Working depth of the implement must be controlled by changing the gage-wheel setting either of two ways—both of which require a two-function hydraulic system which few tractors today possess.

3. Depth gaging by adjustment of suction in the implement—This method of gaging is used on some hitches, especially with moldboard plows which respond readily to suction adjustment. Its principal advantage is mechanical simplicity. It lends itself to any hydraulic system. In addition, the fore-and-aft leveling means of the hitch can also be used for depth adjustment.

Implements so controlled normally vary considerably in working depth when operating over uneven ground or in varying soil conditions. Implements that are relatively short, such as subsoilers and some types of cultivators, do not respond to this method of depth control.

4. Depth gaging by adjustment of hitch point in a vertical plane—With this method of depth control, the hitch point is raised or lowered until the implement is working at the desired depth. Although relatively effective, this system is not used extensively because it is usually cumbersome and somewhat complicated. Also, a wide range of vertical adjustment is needed to meet the requirements of all implements.

An implement using this system usually varies considerably in working depth with varying texture of soil.

5. Depth control by means of implement draft or load reaction—With this method, implement draft or load is used as the means for gaging working depth. The system works on the assumption that working depth is a function of implement draft. A force proportional to the implement draft acts through the hitch which is connected by a linkage to the control mechanism of the hydraulic system. The hydraulic system then acts to raise or lower the implement as the load increases or decreases.

This type of depth control has the most appeal in the one and two-bottom plow tractor size, in my opinion. It permits a tractor and implement to negotiate very uneven terrain without objectionable variation in implement working depth where soil is fairly uniform. Also, a tractor can be operated through hard or heavy spots in a field without experiencing either traction or power stalls (but at a sacrifice in working depth). This gives the tractor operator a feeling of high horsepower reserve. On tractors having a large horsepower reserve for a particular implement, a control which would hold the implement at a constant working depth might be more desirable than load or draft control.

Proper Ground Relationship

Hitch design should be such that the implement is maintained in proper relation to the ground as tractor and implement are operated over uneven terrain. It is desirable that the working depth through swales and over hills be about the same as the working depth on level ground.

The hitch should permit the implement to enter the ground to its working position in a relatively short distance. It should also carry the implement at a safe and secure height above the ground in transport.

Provision for Remote Hydraulic Cylinder

With the trend toward more versatile and powerful tractors and larger integral implements, provision should be made in tractors for a remote hydraulic cylinder. This remote cylinder should be able to be operated independently from, and simultaneously with, the tractor rockshaft.

Tractor Longitudinal Stability a Must

To transport the large or heavier rear-mounted integral tools with safety, adequate weight must be retained on tractor front wheels so that the tractor can be steered over rough terrain and up inclines. Since rear-mounted pickup tools are here to stay, more tractor front-end weight will be required than has been necessary in the past. Therefore, some means should be provided for readily attaching a reasonable amount of ballast to the front end of a tractor. This weight, however, must be readily removable to cover times when implements are mounted on the front end of a tractor.

Implement Designers Have a Job Too

These, then, are the things that implement manufacturers would like to see tractor engineers incorporate in implement hitch and hydraulic systems. Now let's consider what implement designers can do to improve the situation.

Some implements, due to their size or special operating characteristics, may not respond properly to the depth control means provided on a tractor. Such tools may require independent gage wheels, and it's up to implement designers to provide them. With such an arrangement, depth is varied by means of a lever or screw crank which can be reached from the tractor seat, or by use of a remote hydraulic cylinder.

Other implements, such as a 4-row lister, are

difficult to control laterally without gage wheels, especially over uneven terrain. If the lister bottoms on the right side are operating at a greater depth than those on the left, the tractor becomes difficult if not impossible to steer. Such implements, therefore, must be designed so that they can float laterally.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Excerpts from Discussion by

E. W. Tanquary

International Harvester Co.

• The time required to change over from mounted implements to drawbar or power-take-off operation is just as much a part of the attachability problem as the time required to change from one mounted implement to another.

• We see no objection to setting up a recommended practice covering the three attaching points for implements designed for use with a 3-point linkage. . . . While establishing these common points will permit mechanical interchangeability, it will not, however, insure interchangeability from a functional standpoint.

• Where depth control is obtained by adjustment of the hitch point, it is important to have some means for locking the hitch; for allowing the rear of the hitch members to float; for maintaining the hitch members in a fixed, horizontal plane.

W. E. Todd

Massey-Harris Co.

• If there were some standardization of the height of the hitch points on implements (taking into consideration the depth at which an implement normally works), it would simplify the hitch designers' problems.

• If the proposed British standard for 3-point hitches is generally acceptable and followed, it will facilitate interchangeability of implements in the export field.

• If the hydraulic system and hitch provide for more than one means of depth control, better performance will be obtained from a wider range of implements.

• Lifting capacity of the hydraulic system should be at least 25% greater than that required to lift the maximum weight recommended for the tractor in transport. This reserve is necessary to lift an implement out of the ground and to provide for momentary loads.

W. E. Knapp

Minneapolis-Moline Co.

• Implement designers have not yet been able to tell tractor engineers just what is desired in the way of performance in larger implements.

• Maneuverability may not be too great a consideration with larger tractor implements, since larger tractors are used on farms which contain few small or irregular fields.

• Perhaps we should ask, "What should be expected of the ideal hitch?" For example, would it be desirable and economical to mount portions of a corn picker on this hitch? How about a baler or other heavy harvesting equipment?

• Implement engineers cannot develop the ideal hitch by themselves. It will only result from closely coordinated work with tractor engineers . . . and eventually an industry-wide program to obtain interchangeability of various makes and models of both tractors and implements.

L. G. Kopp

Oliver Corp.

• We believe that the objective of having common implement-to-tractor attaching points is good. However, we anticipate that the constant search for improved products will cause such constant change that a satisfactory standard would not remain so for any reasonable time.

• With improved attaching points, semi-mounted implements can become a solution to the transport-stability problem with large tractors.

• A drawn implement which has an automatic coupling point and a self-supporting hitch may be coupled more rapidly than any multiple-attaching-point mounted implement.

S. C. Heth

J. I. Case Co.

• Implement men should not lose sight of the following major disadvantages connected with mounting some tools:

1. Weight required for penetration, when needed "way back," is difficult to apply.
2. Down-pressured carrier arms (to add weight to implements) remove weight from tractor rear wheels with obvious ill results.
3. Need for special pivoting arrangements on some tools.
4. Most tools are not self-gaging as regards depth control unless provided with carrier or gage wheels.
5. Most mounted implements can't be hooked up as fast as comparable drawn implements under conditions actually encountered on a farm.
6. Resultant of forces in larger implements is not constant and projected draft lines vary.

News of SAE

TEAMWORK . . .

. . . of engineers and production men to keynote Chicago meeting.

TODAY'S automotive and aircraft industries are undergoing a subtle, but significant metamorphosis, observes the SAE Production Activity Committee. It's this: More and more engineering and manufacturing departments are abandoning rugged individualism and working together rather than independently on product problems.

That's why the Committee has arranged to have this "new look" in industry aired at the SAE National Production Meeting in Chicago, March 29-31, at the Drake Hotel.

For example, among the papers at this meeting keyed to the theme of the "Production-Design Partnership" will be one by Chevrolet's general manufacturing manager and chief engineer, E. H. Kelley and E. N. Cole, respectively. In their talk on the "Engineering and Production Team," these men will show how teamwork on Chevrolet's product program gets jobs done on time and within specified costs.

Manufacturing methods development is one way of bridging the gap between engineering design and production. That's what R. J. Moran, of Wright Aeronautical, and Dr. Michael Field, of Metcut Research Associates, will say at the Meeting. They will show that in the aviation industry today, new manufacturing processes have to be developed to keep pace with stringent design needs.

The differences in approach to production planning between mass-production operation and job-shop operation also will get a going-over. The high-speed production picture will be given by C. A. Nichols and W. A. Fletcher, Delco-Remy Division, GMC. The problems in smaller plants will be dished up by J. E. Adams, White Motor Co.

Preceding the day of technical session (March 30), will be a full day of Production Forum panels. Forum Co-Chairman Emil Wirth and Carl Hecker developed their eight-panel Forum after an extensive survey of production men the country over.

Wirth and Hecker asked manufacturing engineers what are their current problems and in what areas would they like to hear advice from specialists. The result is eight panels loaded with top names in manufacturing on automation, quality control, manufacturing expense control, production and material control, and other equally important manufacturing areas.

R. C. Archer, general chairman of the meeting, advises that the dinner program scheduled for March 30 will be an outstanding one. Highlight of the dinner program will be a talk on "Thinkin' Tall," by Dr. Kenneth McFarland, an inspirational speaker who has fascinated countless dinner audiences.

The two plant trips on the third day of the meeting are the icing on the cake. The plants to be visited are Hotpoint and the Melrose Park Works of International Harvester.

■

EMBLEM CONTEST CLOSES . . .

. . . April 1 for all designs submitted in 50th Anniversary emblem competition.

TIME is slipping by quickly for the more than 700 SAE members who have said they want a crack at the $200 first prize in the SAE Golden Anniversary Emblem Contest.

Contest rules specify that all designs must be postmarked no later than April 1. **So it's later than you think, contestants.**

So far only a relatively small percentage of the entrants have submitted designs. But applications are still pouring in.

Contestants are urged to submit their designs as soon as possible. Early submission may spell the difference between winning and losing the $200 first prize. Here's why: In case of a tie vote among the judges, the earliest entry will be given the award.

In addition to the $200 first prize, the judges will select 10 honorable mention award winners who will be presented with certificates. All winners will be announced in the July 1954 issue of the SAE Journal by the SAE Public Relations Committee, which will judge the designs.

1953 SAE Journal Index . . .

. . . is available to members and subscribers free upon request. It covers the twelve 1953 issues (Vol. 61).

■

N. Y. FORUM . . .

. . . injects new note with luncheon program starring Air Force official.

PLANNERS of the SAE 1954 Aeronautic Production Forum have tied a ribbon around the package in wrapping up their program. They have scheduled a luncheon on April 12 the day of the Forum, at the Hotel Statler, featuring a talk on "Quality Air Power" by Roger Lewis, Assistant Secretary of the Air Force for Materiel.

Lewis will bring to the meeting an extensive background in aviation. He has been with Lockheed, Canadair, and Curtiss-Wright ever since his graduation from Stanford University in 1934.

Scheduling a luncheon at an SAE Production Forum is a new feature. Forum Sponsor R. T. Hurley and General Chairman Michael Field felt that it would furnish an added service to the men who attend the morning and afternoon panel sessions. It provides them with a facility for staying together and adds another attraction to the Forum.

The Forum itself this year focusses on "Economy in Aeronautic Production." Seven panels are scheduled. They are: (1) Quality Control, (2) Metallurgical and Chemical Processing, (3) Understanding Factory Cost Control, (4) Reducing Costs Through Manufacturing Methods, (5) Lead Time and Engineering Changes, (6) Factory Personnel Relations, and (7) Production Control.

Roger Lewis, Assistant Secretary of the Air Force for Materiel, who will address a luncheon at the Aeronautic Production Forum in New York, April 12

SAE National Meetings . . .

1954

March 29-31
National Production Meeting & Forum
The Drake, Chicago, Ill.

April 12-15
National Aeronautic Meeting, Aeronautic Production Forum, & Aircraft Engineering Display
Hotel Statler, New York, N. Y.

June 6-11
Summer Meeting
The Ambassador, Atlantic City, N. J.

August 16-18
National West Coast Meeting
Hotel Statler, Los Angeles, Calif.

September 13-16
National Tractor Meeting & Production Forum
Hotel Schroeder, Milwaukee, Wis.

October 5-9
National Aeronautic Meeting, Aircraft Production Forum, and Aircraft Engineering Display
Hotel Statler, Los Angeles, Calif.

October 18-20
National Transportation Meeting
The Sheraton-Plaza
Boston, Mass.

October 26-27
National Diesel Engine Meeting
Hotel Statler, Cleveland, Ohio

November 4-5
National Fuels and Lubricants Meeting
The Mayo, Tulsa, Okla.

1955

January 10-14
Golden Anniversary Annual Meeting and Engineering Display
The Sheraton-Cadillac Hotel and Hotel Statler, Detroit, Mich.

SAE National Production Meeting

March 29-31, 1954

The Drake, Chicago, Illinois

will be keyed to the theme of

"Production-Design Partnership"

This three-day meeting will serve up a varied, interesting fare. Its highlights:

- PRODUCTION FORUM . . . Monday, March 29
  Eight panels on vital production problems manned by leading engineers and manufacturing men.

- TECHNICAL PAPERS . . . Tuesday, March 30
  Focussed on need for greater coordination between engineers and production men.

- TOP-NOTCH DINNER PROGRAM . . . Tuesday, March 30
  With an entertaining, thought-provoking talk by Dr. Kenneth McFarland.

- PLANT TRIPS . . . Wednesday, March 31
  Two of Chicago's most interesting plants:
  Hotpoint and International Harvester's Melrose Park Works.

YOU'LL . . .

. . . be interested to know that . . .

SAN ANTONIO area in Texas has been transferred to the recently inaugurated Texas Gulf Coast Section . . . from Texas Section territory. Change involves 51 counties.

★ ★ ★ ★

SAE ALBERTA GROUP has been authorized by SAE Council in place of the informal Alberta SAE Club which has been functioning for some time. Membership of this new Canadian group centers mostly in the cities of Calgary and Alberta.

★ ★ ★ ★

HERBERT HAPPERSBERG in 1954 will again be SAE's representative at the Annual Safety Convention and Exposition of the Greater New York Safety Council. The event will be at the Hotel Statler, New York City, on April 4 to 9. A past-chairman of the Metropolitan Section, Happersberg is assistant to the president, Brockway Motor Co., Inc.

★ ★ ★ ★

SOUTHERN METHODIST UNIVERSITY now has an SAE Student Branch. SAE Council approved its installation on a recommendation from the SAE Student Committee presented by Committee Chairman R. R. Faller. Faller is Ethyl Corporation's manager of training.

★ ★ ★ ★

LEONARD W. CONRAD, factory manager of the Heil Co., has accepted the invitation to serve as general chairman of the 1954 Tractor Production Forum in Milwaukee, Sept. 13.

★ ★ ★ ★

TURBINE-DRIVEN vehicles researched by General Motors Corp. will be the subject of the Wednesday evening session, June 9, during the SAE 1954 Summer Meeting.

★ ★ ★ ★

THE SAE PRODUCTION ACTIVITY COMMITTEE has selected Cincinnati as the site for the SAE 1955 Golden Anniversary Production Meeting. It is planned to hold the meeting in March.

★ ★ ★ ★

AT ITS January 15, 1954, meeting, the Council amended the rules of the

Coker F. Clarkson Memorial Fund to transfer the administration of the fund to the SAE Finance Committee and to disband the Clarkson Memorial Fund Committee, formerly charged with the administration. In accordance with the provisions of the Clarkson Rules this amendment becomes effective immediately.

NOISE . . .

. . . of turbine engines will be topic at Aero Meeting symposium in New York.

JUST about anything you want to know about noise of aircraft turbine engines you can find out by attending the SAE National Aeronautic Meeting.

At least you ought to be able to find it out at the Wednesday, April 14, symposium on aircraft noise if you can find it out anywhere. Eight of the country's leading experts on the subject are scheduled to present papers at morning and afternoon sessions at New York's Hotel Statler.

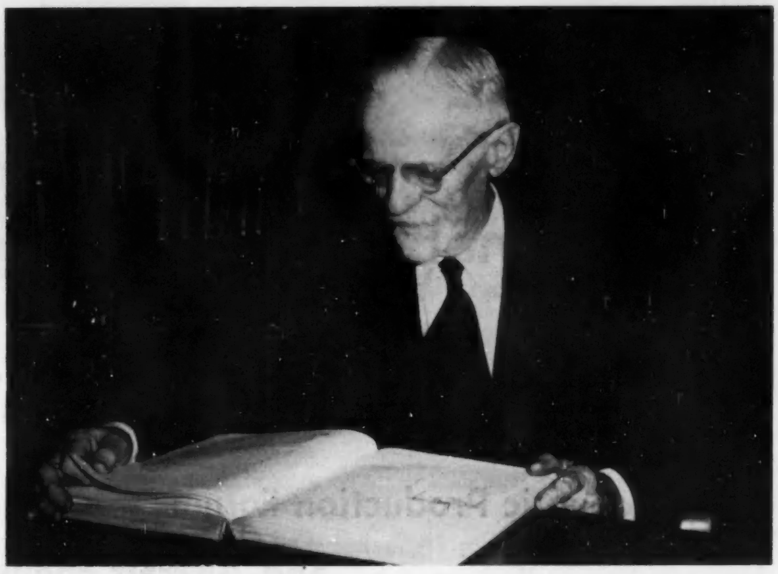
First speakers will explain what sound is and how the turbine engine generates it. Later speakers will consider how to suppress sound for the comfort of passengers and people living near engine test stands and airports.

Symposium speakers for the morning session include: A. C. Pietrasanta of Bolt, Beranek and Newman, Inc.; A. A. Regier of NACA; R. O. Fehr of General Electric; and H. W. Withington of Boeing. On the afternoon program are: John Tyler of Pratt & Whitney Aircraft; Joern Schmey and R. M Guerke of Curtiss-Wright Propeller Division; and Com. Charles E. Rosendahl of the National Air Transport Coordinating Committee.

SAE President William Littlewood, American Airlines' vice-president for engineering, will preside over the two sessions. Herbert O. Fisher, chief of aviation development for the Port of New York Authority, will be session secretary.

The symposium is sponsored jointly by the SAE Air Transport, Aircraft, and Aircraft Powerplant Activities. The SAE Aeronautic Meeting—of which the symposium is a part—begins on April 12 with 10 all-day production clinics and continues with technical sessions April 13-15. The Meeting will close Thursday evening, April 15, with a dinner at which Gill Robb Wilson, editor and publisher of "Flying," will speak.

In 1902, He Suggested an SAE . . .



Peter M. Heldt wrote an editorial in *Horseless Age* in 1902 which first suggested a Society whose field of major activity would be "the purely technical side of the automobile."

And at its September, 1953 meeting, SAE Council awarded the famous technical writer a Life Membership in the Society of Automotive Engineers.

Referring to the 1902 editorial in making formal presentation of the honor to Heldt, SAE's 1953 President Robert Cass said: "It is fair to say that this editorial was the seed from which Ed Birdsall's efforts brought to fruition just such a society, The Society of Automobile Engineers, in 1905." The presentation was made at the February 9th meeting of the SAE Metropolitan Section.

In the presentation, Cass recalled that after SAE was organized, Peter Heldt became one of its pioneer members. "He joined in 1906," Cass said, and, "during his nearly half-century of membership, became the recognized top authority among technical writers in the automotive world. His thousands of technical articles have been post-graduate engineering courses to thousands of automotive engineers of all ages.

. . . And his textbooks—which he keeps up to date by constant revisions and new additions—are standard authorities in their fields in both universities and in the engineering departments of industry."

Throughout most of his life, Heldt was engineering editor of *Automotive Industries*, a post from which he retired several years ago.

Presentation of a Life Membership in SAE to P. M. Heldt was made at the February 9 meeting of the SAE Metropolitan Section. Left to right: Heldt, Met Section Chairman N. P. Flynn and 1953 SAE President Robert Cass

from the Sections

Addition of nine new vice-chairmen for specific activities were authorized for three Sections by SAE Council at its January 15 meeting.

Southern New England Section has two of the new vice-chairmen: one for Engineering Materials; the other for Production . . . the recently inaugurated Texas Gulf Coast Section has five: one each for Diesel Engine, Fuels & Lubricants, Production, Transportation & Maintenance, and Truck & Bus . . . the other two have been added by Cleveland Section: one for Diesel Engine; the other for Fuels & Lubricants.

Texas Gulf Coast

Field Editor
W. B. Tilden
Jan. 8

INVESTMENTS OF THOUSANDS and often hundreds of thousands of dollars are made in the drilling of each hole for oil exploration and production. The oil man must obtain from his drilling the **greatest possible information** as to his prospects of achieving oil or gas production.

He wants an accurate estimate of the extent of such production as well as the nature, depth, and thickness of the various formations he has penetrated with the bit. He needs to know which formations are porous and permeable and the nature of the fluid contained in these formations. The 130 members and guests of the Texas Gulf Coast Section, on a tour of the Schlumberger Well Surveying Corp.'s new 36 acre plant at Houston, learned how this data is obtained.

Schlumberger Well Surveying Corp. keeps more than 300 fully equipped mobile science labs in operation. Exploratory surveys are made thousands of feet below the earth's surface. Large 10-wheel field units mount a heavy power winch, with thousands of feet of steel **armored electrical cable**, sufficient on some units to probe as deep as four miles into the earth. In a cab ahead of the winch, members saw an array of **ultra-modern** electronic control panels, conduits, switches, power supplies, a special automatic recorder, dark room, and a printing machine for producing copies of survey results.

Schlumberger has 25 electrical and radioactive well surveying and production services. However, of the services offered, the electrical log is the pioneer and still the basic service.

Hawaii

Field Editor
R. G. Deemer
Jan. 18

SINCE THE WRIGHT BROTHERS' first flight, the aviation industry has grown to such an extent that it is now ranked in size by the automotive industry only. This is what Dr. John Harvey Furbay told members in presenting his paper, "Aviation Comes of Age." Dr. Furbay is director of Trans World Airlines' Globe Air World Education program.

He said that **air traffic** now makes it possible to develop the 65% of the globe which is not reached by water or land transportation. Growth of **surface transportation** is being speeded up through the development of previously uncivilized areas.

Cited as an example of this growth was one region of Africa where a mining operation is being carried on 500 miles from the nearest surface transportation. Personnel and equipment, (including bulldozers) are flown in and the mined product flown out to the nearest railroad. Thus cargo is made

Southern New England (Jan. 28)

CONGRATULATING SAE's new president, William Littlewood, is Perry Pratt (right), who was technical chairman of the meeting. Littlewood was speaker.

From Section Cameras

Western Michigan (Jan. 19)

A. T. COLWELL, vice-president of Thompson Products, Inc., Cleveland, presents a paper on the latest developments in military aircraft. Colwell is a past-president of SAE.

available to other carriers which would not be available otherwise. Operations of this kind also place money in undeveloped areas which means **extending markets.** According to Dr. Furbay, communities not willing to create and maintain airports capable of efficiently handling the newest types of aircraft and the business they create, will "die on the vine."

Southern New England

Field Editor
A. D. Nichols
Jan. 28

FUTURE AIR TRANSPORTS will fly faster, higher, farther, safer, and more economically than present transports. That's what William Littlewood, SAE's president for 1954 told members at this meeting.

Littlewood predicted that some time about 1960–65 we will have transports that will cruise at the rate of 600 mph. Engines required to power these high-speed transports will be some form of turbine-engine, turbojet, turboprop, or by-pass turbines. These planes will be approximately the same size as our present ones, carrying 80–100 passengers and 20–25% more passengers for tourist service.

Airplanes will cruise at about 45,000-ft and there will have to be increased **cabin pressurization** which must be accompanied by more safety to protect passengers against **sudden decompression.** Cargo will be handled faster and more economically.

For shorter hops, Littlewood said, there is great need for some type of helicopter. However, these transports must be capable of cruising up to 400 mph at 20,000-ft, and carry 50–60 passengers. Littlewood believes the helicopter is the answer to many problems.

Perry Pratt, chief engineer of Pratt & Whitney Aircraft, was the technical chairman of the meeting. Donald Blanchard Secretary of SAE's Technical Board delivered a short address in which he honored the Southern New England Section men who are serving on technical committees of the Society. They were: Arthur Nutt, Erle Martin, Wright Parkins, John Perrin, Paul Eddy, Paul Gilligan, and Val Cronstedt.

Twin City

Field Editor
S. H. Knight
Jan. 28

THE ELECTRON MICROSCOPE is being used as a research tool and as a control unit for successful operation of internal-combustion engines. That's what Ray McBrian, engineer of standards and research for the Denver and Rio Grande Western Railroad Co. told Section members.

McBrian said that the electron microscope is necessary in internal-combustion engine lubricating oil control because with it one can tell from the appearance of the oil: (1) if the oil is stable or, (2) if it is well and **properly dispersed,** or (3) if there is a **loss of additive**—even though by all other methods of analyses and standards, the oil meets definite tests and requirements. McBrian is using the electron microscope not as a specification control stick, but as an aid in understanding how to secure and maintain the best operating conditions.

Not only does McBrian use this microscope in the study and evaluation of fuels used by his own railroad and its subsidiaries, but for other companies in their studies of: gasolines, including **high-octane gasoline;** diesel fuels, of various grades and sulfur content; kerosenes; jet fuels; and residual types of fuels such as Bunker "C."

McBrian said his studies are not concerned with comparisons or studies with others. "All we are concerned with," he said, "is to compare our own individual diesel and gasoline-powered equipment with each other and control operating conditions. That, from the dollars and cents savings standpoint, is all that is necessary for us to do, and the final pay-off is only reflected in financial statements and in operating cost figures."

He thinks that from these studies of internal-combustion engine fuels and lubricating oils, the way has been opened for an entirely new and different conception of the characteristics of these materials. This new field of **physical colloidal chemistry** may develop a better understanding of how these materials can be used and may change the entire conception of "specification writing"—in some cases, of the basis of engine design.

"It should be remembered," he said, "that . . . we will let the engine tell us, in each and every study, actually what is taking place. After all, that is the final and sure criterion."

Northwest

Field Editor
S. J. McTaggart
Jan. 8

TRI CRESYL PHOSPHATE additives in gasoline render lead combustion chamber deposits nonconductive, but do not remove them. This was pointed out at the Section's Fuel and Lubrication Question and Answer Symposium.

A few other interesting facts brought out by questions were:

1. Compounds in heavy duty motor oils expire before the base stocks.
2. **Synthetic oils** will not be widely used commercially for several years. Present uses are restricted to highly specialized applications such as jet and rocket motors.
3. Multi-purpose "buttery" chassis lubricants are expected to replace special purpose lubricants.

Emphasis was placed on questions arising from normal, everyday use of petroleum products. A typical question was, "What causes foaming in **gear oils?"** The answer: "Foaming is the result of trapped air bubbles that are unable to escape fast enough from the oil. Three primary causes are:

San Diego (Dec. 15)

From Section Cameras

LOOKING UP are the drivers of the Lincoln automobile in the 1953 Mexican Road Race. They spoke at San Diego's December meeting. Left to right are: John Holman, driver of the service truck; Vern Houle, transmission specialist and co-pilot for Bill Vukovich; Bill Stroppe, co-pilot for Johnny Matz; Clay Smith, co-pilot for Chuck Stevenson; Walt Faulkner, second place driver; Frank Ruppert, Pomona Lincoln-Mercury dealer and sponsor of winning car; Chuck Stevenson, driver of winning car; Johnny Mantz, driver of fourth place car; Chuck Daigh, co-pilot for Faulkner. Car number 53, in the background, is Faulkner's second place Lincoln.

South Bend Division of Chicago (Jan. 25)

"KEEPING COOL in air conditioned autos" was the subject at this South Bend meeting. Left to right: T. Earl Wagar, chief electrical engineer, Studebaker Corp.; Chicago Section vice-chairman H. Drapeau; Section Vice-Chairman of Passenger Car Activity D. J. Schrum; J. W. Duhn, assistant chief engineer, electrical section, Chrysler Corp.; Section Chairman M. R. Bennett; J. Greenley, vice-president, Imperial Brass Mfg. Co.; and G. W. Pontius, automotive manager, Bendix Products Division. Duhn, fourth from left, presented the paper, "Lessons Learned and Problems Ahead in Automobile Air Conditioning," by P. J. Kent, chief engineer, electrical section of Chrysler.

(1) over filling, which reduces the air space above the gears, (2) using excessively heavy oil, and (3) dirt.

Giving the answers from the speakers' table were: S. M. Baumsgard, General Petroleum Corp.; W. R. Linington, Richfield Oil Co.; H. H. Hayduk, Shell Oil Co.; E. C. Rawlings, Standard Oil of California; W. H. Peterson, The Texas Co.; C. C. Kinsey, Union Oil Co.

Central Illinois

Field Editor
W. J. Lux
Jan. 25

POWDERED METAL PRODUCTS have found wide usage in many unique and varied fields, and the exploitation of **"powder metallurgy"** has just begun, according to D. B. Martin. Martin is vice-president of the Amplex Division of Chrysler Corp.

He said that powder metallurgy provides materials with physical characteristics and **manufacturing potential** not possible with normal metals and alloys.

The original problem, which led to the development of Oilite products, was to make a self-lubricating clutch pilot bearing. In powdered metal processes, the lubricant can be included with the metal, thus eliminating grease fittings or periodic repacking of bearings.

Since the development of the original bearing, the processes have been improved and widened in scope until now, several hundred products, including bearings, filters, and electronic units are made for all fields of industry.

After-dinner speaker was Bill Houlihan, staff announcer for WEEK-TV. He discussed local television conditions and plans, and pointed out TV's rapid rise and present importance both in entertainment and in advertising.

Dayton

Field Editor
P. J. Long
Jan. 19

"AUTOMOTIVE TRANSMISSION has always been, and still is, required to compensate for the shortcomings of an internal combustion engine." That statement was made by R. J. Gorsky, staff engineer, Buick Transmission Division, GMC.

Gorsky said that the internal combustion engine, as we know it today, cannot run below approximately 400 rpm without stalling. "It develops relatively **little torque** at low speed, where the torque demand is the greatest to obtain good car acceleration; and it cannot be made to run counterclockwise readily to reverse the motion of the vehicle."

"Therefore," Gorsky said, "the primary purposes of a transmission (or a transmission and clutch combination) are to prevent the engine from stalling when the car speed is low or zero; to enable the engine to operate at a higher speed where it develops more power while the transmission multiplies the engine torque for better acceleration; and to reverse the rotation of the drive shaft, using a gear train to provide a means of reversing the vehicle motion. These requirements can be obtained in many ways as one realizes when he sees the many types of transmissions which have been used in the past 50 years."

Gorsky said that there are many secondary requirements which are expected of **transmissions today**; such as ease of operation, smoothness, maximum car performance, best fuel economy, cost of manufacture, and weight. "Everyone evaluates these items in a slightly different manner and no one combination has been arrived at which has the best of all items. Consequently, compromises must be made which result in different **transmission designs** and the perpetual argument, as to which is the best, goes on."

Buffalo

Field Editor
D. I. Hall
Jan. 14

SOMETHING FROM NOTHING is obtained in vacuum-operated mechanisms, E. C. Horton told members at the January meeting. Horton is chief engineer of Trico Products Corp., Buffalo, N. Y.

In talking about **"Lift-O-Matic,"** a vacuum-operated system for raising and lowering car windows, Horton pointed out qualities and advantages of the system.

Horton also told of another recent development by Trico Products, the **"Co-ordinator."** To operate the Co-ordinator, the driver pushes a button and releases it immediately. From then on the system is automatic. It squirts water onto the windows, operates the windshield wipers for a predetermined length of time, and then shuts off, or returns the wipers to their original speed.

Pittsburgh

Field Editor
O. B. Rosstead, Jr.
Jan. 26

CAUSES AND CURES of exhaust-valve burning were discussed by P. H. Richard. Richard is with the Petroleum Chemicals Division of E. I. du Pont de Nemours & Co.

He said that anything that can be done by the engine builder, maintenance mechanic, parts supplier, or engine operator to reduce the heat load imposed on the valve head, or to make it easier to transfer quickly to cooler parts of the engine, will reduce valve burning.

Richard also presented data, in curve form, on how temperature affects the rate of valve steel corrosion. Regardless of the **valve steel alloy** used, the curve path for each is very much the same although located at different points along the temperature ordinate. Corrosion takes place at a low and very

From Section Cameras

Twin City (Jan. 28)

POINTING TO PHOTO-MICROGRAPH is Ray McBrian, who spoke about the electron microscope. To his left is S. H. Knight, Section Field Editor, and to his right are H. Bruce Hoesly, mechanical engineer for Northern Pacific Railway Co., St. Paul; and Burton Robertson, consultant to chief engineer, test, Aero Division, Minneapolis-Honeywell Regulator Co., Minneapolis.

THE GENERAL COMMITTEE formulates plans for Peoria Section's Fifth Annual Earthmoving Industry Conference, April 13 and 14. Left to right are: J. W. Carter, secretary; R. E. Kennemer, Section chairman; R. H. Williams, publicity; R. M. Smith, general chairman; D. K. Heiple, finance; Eugene Brookhouzen, program; Harlan Banister, treasurer; and W. S. Sydnor, arrangements.

slightly increasing rate up to a certain temperature. Above this point, which Richard referred to as the "critical point," the rate of corrosion increases rapidly. In fact, an increase of only 100 deg at this point will increase the rate of corrosion by ten times.

Thus it can be seen that valves working just below the critical point will give very satisfactory service, but with identically the same setup and the engine working just a little harder, valve life will be very short.

South Bend Division of Chicago

Field Editor
D. W. Miller
Jan. 25

THE PRESENT AND FUTURE market potential, as well as problems encountered in automotive air conditioning, were discussed at this meeting. J. W. Duhn presented "Lessons Learned and Problems Ahead in Automobile Air Conditioning," a paper written by P. J. Kent, chief engineer of Chrysler's electrical section. Duhn is assistant chief engineer of the section.

Whether the ultimate design will be **a package unit** or will follow present practice is yet to be determined. Future development, however, will be required on compressors to reduce size and weight, **less bulk** to reduce space required, lower cost, simplification of system and controls, condensor cooling as related to normal engine cooling, and on the method of driving the compressor as well as other engine accessories. All development must be coordinated with automobile styling as well.

Technical chairman for the evening was D. J. Schrum, engineering research department, Studebaker Corp.

Williamsport

Field Editor
Paul Cervinsky
Feb. 3

THE AUTOMATIC RECORDING cylinder bore gage is unique since once the gage is set upon an engine block, **uneven measurements** are automatically recorded. This minimizes the chance for inaccuracies. That was what W. A. Weinert, supervisor of Ford Motor Co.'s measuring laboratory, told members and guests.

Though at present the gage is used for cylinder bore measuring only, Weinert thinks that it could be adapted for many uses in which tolerances are required or in which distortion must be measured. He said that the gage has made it possible to uncover causes of cylinder bore distortion that may be caused by block design, head construction, torquing procedures, and head gaskets.

In measuring bores in an engine block after the gage is set up, retightening of the cylinder head, sequence of tightening, and torque on bolts, can all be accomplished without disturbing the **gage setup.**

After a discussion period, the movie, "Tomorrow Meets Today" was shown. This film takes the audience on a tour of the Ford engineering labs and depicts all problems, large and small, that are encountered in the development and production of the modern automobile.

Washington

Field Editor
C. Janeway
Jan. 11

PROJECT TINKERTOY, the mechanical system of producing electronics, was the subject of a joint meeting with the Washington Section of the IAS. Harold B. Parker did the explaining. He is head of the **electronic equipment** section, Industrial Planning Division of the Bureau of Aeronautics, Department of the Navy.

Parker said the vast need for electronic equipment for war machinery and the dependence on electrical devices to wage effective warfare, created a need for a system of mass producing electronics. As a result, a method of production was evolved which makes parts equal in quality and performance to products that were almost handmade previously. The new method also increased the possibility of **standardization** of many electronic components.

The project was begun in 1950 with a contract let to the Bureau of Standards. Because of the Korean War, the project was reduced from a planned eight to ten years, to two years.

A film, "We Saw It Happen," was shown in the second half of the meeting. It depicted fifty years of powered flight. Charles J. McCarthy, vice-president of United Aircraft, was narrator.

Kansas City

Field Editor
M. L. Werth
Jan. 21

"FUTURE TRENDS in Air Transportation," was the subject presented by R. K. Rourke. Rourke is manager of aircraft economic analysis for Trans World Airlines.

He said that along with larger payload, range and speed, desires for the future are **greater economy** and dependability of air-transports. To achieve these, **more power** seems to be the answer. To secure this power, the trend appears to be towards the turbine engine—either turbojet or turboprop. There is much controversy as to which is the most desirable.

The jet has a constant thrust at the same altitude, but is not very efficient on fuel consumption. The turboprop is better for short hauls. With more

From Section Cameras

Texas Gulf Coast (Jan. 8)

THE MAN BEHIND THE MIKE is W. J. Gillingham, executive vice-president of Schlumberger Well Surveying Corp. Gillingham spoke to Section members before they were conducted on a tour of one of his company's plants. At the table are: (left to right) Section Chairman E. J. Strawn; O. H. Stelter Co-chairman of the Production Activity Committee; and Paul Barth of T. S. C. Motor Freight Lines.

Williamsport (Feb. 3)

GETTING ATTENTION is an automatic recording cylinder bore gage. Examining the gage are: (left to right) Section Secretary Allan Weiss; Martin Maloy, field engineer in charge, Burlingame Associates; Section Chairman Fredric Rohm; and Section Meetings Chairman, Blair Kratzer.

research and development of **better propellers**, it may become a greater competitor of the jet.

Design problems and limitations for future planes are: (1) weight and range, (2) runway length, (3) speed range. Runway lengths must be sufficient to allow a plane to stop after the decision speed is reached in take-off. Since runway lengths are limited in many cases, sizes and speed of planes are also limited. As a result, many design compromises will come in the future with probable places for both the turbojet and turboprop engines.

Mid-Continent

Field Editor
G. A. Carlson
Dec. 4

"THE VALVE GEAR DOCTOR first must have knowledge and experience. He must diagnose the ailments accurately and not be just a pain killer." That's what Vincent Ayres told members at this meeting. Ayres is assistant chief engineer of the Valve and Saginaw Divisions, Eaton Mfg. Co.

Ayres said that the valve gear doctor's problem is . . . "to effect a cure, remembering that what cures one patient may kill the next, even if in the same family. There are solutions, fixes, and gimmicks, any of which might be an answer to your problem. Test them carefully, look at the results with open eyes and **open minds**, and do not sacrifice **fundamental principles** for expediency. If it is fundamentally sound, it has a better chance of **being right.**"

Speaker Ayres' final advice was, "Like **buttoning a vest**, he who starts with the wrong button may end up in the hole."

Salt Lake

Field Editor
W. P. Barnes
Jan. 18

ENGINE OIL CHANGES should be made only when laboratory tests indicate a need for change—not every-so-many thousand miles of engine operation. That is the opinion of L. C. Atchison, assistant test engineer and former chief chemist for the Denver and Rio Grande Western Railroad Co. **Three lab tests** from which Atchison drew most of his conclusions concerning the condition of oil were the flash point, dirt, and ash content tests.

Atchison said that as a guard against possible **crankcase explosions**, any oil in the diesel engine fleet that has a flash point lower than 360 F is drained immediately. The critical percentage of dirt varies somewhat with locality, but Atchison said that his company believes firmly in preventive maintenance, using several tons of filter cotton per month.

Spectrometry plays a prominent part in ash content analysis. Through this method relative amounts of copper, lead, silicon, aluminum, and chromium can be found.

Atchison also indicated that maintenance and operating costs are lessened by running diesel engines at or near 180 F.

San Diego

Field Editor
F. C. Heinig
Dec. 15

"THE MEXICAN ROAD RACE is expanding and improving with each year." That was what Frank Ruppert told the 250 persons attending the San Diego Section meeting. Ruppert was sponsor of the winning Lincoln car in the 1953 Mexican Road Race.

He said that all of the **winning Lincolns** were stock cars. However, parts were selected to give maximum benefits of allowable tolerances. The only changes, according to Ruppert, were: removing rear seats to install **extra fuel tanks** and crash bars, and adding safety belts for the drivers.

Movies of the '53 race were then shown, including views of hazardous hairpin turns on mountains in which speeds over 100 mph were maintained.

Mid-Michigan

Field Editor
C. A. McKinney
Jan. 25

"UNITIZED BODY DESIGN" was presented by L. H. Nagler. He is assistant to the executive vice-president of Nash-Kelvinator Corp., Detroit.

Nagler said that he used the term "unitized" to describe the type of automobile construction in which the body forms the major structural member—rather than utilizing the body primarily as a passenger-carrying shell mounted on a separate chassis frame. He said that this method of building a car occasionally has been referred to as "Frameless" construction and as "Single-unit" construction.

"For a number of years (since 1949) Nash has used the additional term 'Airflyte' construction to denote their combined frame-body structure. Hudson identifies their combined frame-body structure as "Monobilt-Body-and-Frame," while Willys calls their construction, 'Aero-Frame.'"

Nagler said, too, that many makes of European cars use this type of construction, but numerous economic and engineering factors **on the Continent** are different from those in the U.S.A. "Among these factors might be mentioned (1) the greater need for economy in materials used in European manufacturing, (2) emphasis on low gasoline con-

sumption and (3) greater flexibility of **European engineering**, and fewer limitations on design, due to less complicated tooling and smaller plant facilities."

Milton S. Bald, in presenting his paper, "Hudson Mono-Bilt Construction," said there seems to be a general feeling that unitized construction is not adaptable to convertibles. Bald is service engineer for the Hudson Motor Car Co. in Detroit.

"Hudson has been building convertibles for over five years with greater **rigidity of structure** than obtained when using the separate frame and body construction—even with the usual sub-frame assembly which considerably reduced road clearance."

Bald also said that there is very definite evidence that less structural damage is done in a collision on a Hudson Mono-Bilt Body than on a conventional design. "This is particularly true where contact is made on the side of the body. The main structural member, . . . is at the extreme outside . . . and at bumper height. This absorbs the shock preventing major collapse."

St. Louis

Field Editor
A. W. Zub
Jan. 26

AGAIN ST. LOUIS Section had a highly successful theater party. Members, wives and guests attended a show presented by the Webster Theatre Players at the Artists Guild.

Each lady guest was presented with a corsage. Cocktails and a delicious buffet dinner were enjoyed by all.

Cincinnati

Field Editor
E. B. Lohaus
Jan. 26

REINFORCED GLASS FIBER passenger-car bodies have proved a reality, but still are subject to economics and engineering development. Through experimentation, it has been found that 0.1-in. glass fiber is comparable, in tensile strength, to 0.036-in. (20 gage) steel. This is what Carl Jakust told members in presenting his paper, "The Corvette **Plastic Body**." Jakust is with the Chevrolet Division of GMC.

An advantage of the plastic body is the ease with which the **stylists' lines** can be followed without the drawing limitations of steel. Other advantages include the need for only one pair of dies in lieu of progressive die sets, the **shock absorption** qualities of the material, and the lack of welding equipment on the production line.

Repairs are simple if you can find someone familiar with the material to repair the damage. There are three basic **types of damage**: surface cracks, deep cracks and holes, large area and complete panel breaks. However, a good repair job is usually stronger than the parent material.

Milwaukee

Field Editor
D. R. Neeld
Feb. 5

A CAM ENGINE that requires one-half the space and weighs up to 75% less than conventional engines of comparable power, (depending upon the installation) was the subject presented by Karl L. Herrmann. Herrmann started his development of the cam engine in 1936 and continued it mainly because its construction requires 70% **less manufacturing equipment**, 50% less material and 50% less maintenance than a conventional engine with a crankshaft.

He claims that **thousands of hours** of testing on 24 engines have proved its construction and operation eminently feasible. It is primarily intended for aircraft, automobile, truck or locomotive installations and, without major change, is suitable for marine or stationary service, portable air compressors, generators and pump services.

The cam engine, which was on display, incorporates a cam shape designed to produce harmonic motion of the piston. Resulting inertia forces, Herrmann says, are completely washed out in the cam, without reaching any other part.

Feb. 12

"ENGINEERING KNOW-HOW in Engine Design," the second annual lecture series sponsored by SAE's Milwaukee Section, got under way February 12. Reservations for the series included regular members, student members, and nonmembers—a total of 313. Approximately 35 applications for reservations had to be turned down for lack of facilities.

Persons attending all five lectures will receive a bound volume of the lectures, free of charge. The $5.00 fee charged nonmembers is applicable to an SAE membership. Last year this resulted in several such applications. Subjects being presented this year are: "Bearings and Lubrication," "The Induction System and Super-Charging," "The Cooling System," "Two and Four-Cycle Engine Design Considerations" (this will be presented at the regular March Section meeting), and "Evaluation of Experimental Engines."

All Section News . . .

. . . printed in this issue was received by February 11. Ordinarily the 12th of each month is the deadline for the next month's Journal.

SAE SECTION MEETINGS

Baltimore—March 11 and April 8

March 11—Engineers Club. Dinner 7:00 p.m., meeting 8:00 p.m. Aircraft Meeting.

April 8—Engineers Club. Dinner 7:00 p.m., meeting 8:00 p.m.

British Columbia—April 12

April 12—Hotel Georgia, Ballroom. Dinner 6:30 p.m., meeting 8:00 p.m. Air Brakes and Braking Performance. Highway Transport Vehicles—speaker from Bendix-Westinghouse.

Buffalo—March 18 and April 8

March 18—Hotel Sheraton. Dinner 6:30 p.m., meeting 8:00 p.m. New Ford V-8 Engine—K. Vogt, engine designer, Ford Motor Co., Dearborn, Mich.

April 8—Rochester Division. Joint meeting with the Rochester Division in Rochester. Photography in Industry—speaker from Eastman-Kodak.

Central Illinois—March 22

Jefferson Hotel, Peoria, Ill. Dinner 6:30 p.m., meeting 7:45 p.m. The Engineer's Role in our Modern Economy. Panel of students and engineers. Annual Student Meeting.

Cincinnati—March 22

Engineering Society of Cincinnati Building. Dinner 6:30 p.m., meeting 8:00 p.m. Friction Materials—Don Rohrer, research chemist, Grey Rock Division, Raybestos-Manhattan, Inc.

Dayton—March 18

Progress of Development and Application of Commercial Gas Turbine—B. C. Hatch, General Electric Co., Schenectady, N. Y.

Detroit—March 15 and 29

March 15—Rackham Educational Memorial Building. Dinner 6:30 p.m., meeting 8:00 p.m., in the small Auditorium. The Mexican Road Race—Joe Gillette, Lincoln-Mercury Division, Ford Motor Co. Panel Meeting on the Small Gas Turbine, Today and Tomorrow—Fay A. Roepcke, Continental Aviation & Engineering Corp.; Charles A. Amann, Research Laboratories Division, GMC; and Donald Frey, Scientific Laboratory, Ford Motor Co. Moderator—Harold Price, Ford Motor.

March 29—Rackham Educational Memorial Building. Meeting 8:00 p.m. Panel Meeting on Automatic Transmission Production—N. L. Katke, Transmission Division, Ford Motor Co.; W. B. Herndon, Detroit Transmission Division, GMC; and L. B. Bornhauser, Transmission Plant, Chrysler Corp. Moderator—D. T. Sicklesteel, Product Development Laboratory, Borg-Warner.

Indiana—March 11

Purdue University, Lafayette, Ind. Dinner 6:30 p.m., meeting 8:00 p.m. Light Metals in the Car of the Future—J. H. Dunn, manager, Development Division, Aluminum Co. of America.

Metropolitan—March 11 and 17, April 1

March 11—The Brass Rail, Fifth Avenue & 41st Street. Cocktail Hour 5:30 p.m., dinner 6:30 p.m., meeting 7:45 p.m. The Engineer and High Speed Air Transport—1954 SAE President William Littlewood, vice-president, American Airlines, Inc.

March 17—The Engineers Building, 29 West 39th Street, New York 18, N. Y. Fifth Floor. Meeting 7:45 p.m. The Problems and Future of Small Two-Stroke Cycle Engines—G. E. Buske, project engineer, Reo Motors, Inc.

April 1—The Brass Rail, Fifth Avenue & 41st Street. Cocktail Hour 5:30 p.m., dinner 6:30 p.m., meeting 7:45 p.m. Valve Gears' Operational Problems—Vincent Ayres, assistant chief engineer, Eaton Mfg. Co.

Mid-Michigan—March 29

Elks Club, Flint, Mich. Dinner 7:00 p.m., meeting 8:00 p.m. Shell Molding—Harold G. Sieggreen, chief engineer, Central Foundries Division, GMC, Saginaw, Mich. Plant tour of Buick V-8 Engine Plant—4:00 to 6:00 p.m.

Milwaukee—April 2

Milwaukee Athletic Club. Dinner 6:30 p.m., meeting 8:00 p.m. Performance of Free Piston Gas Generators—J. J. McMullen, Hudson Engineering Co., Hoboken, N. J.

Mohawk-Hudson—March 9

Panetta's Broadway, Menands, N. Y. Dinner 6:45 p.m., meeting 8:00 p.m. The New Mercury Engine—P. M. Clayton, assistant chief engine engineer, Ford Motor Co., Dearborn, Mich.

Montreal—March 15

Mount Royal Hotel. Dinner 7:00 p.m., meeting 8:00 p.m. 1954 SAE President William Littlewood.

Northern Calif.—March 24

University of Calif. Dinner 6:30 p.m., meeting 7:45 p.m. Student paper presentations. Students from Stanford, Santa Clara, California Polytechnic Institute, and University of Calif.

Philadelphia—March 10

Engineers Club, Philadelphia, Pa. Dinner 6:30 p.m., meeting 7:45 p.m. Relationship of Valve Gear Design and Operation—Vincent Ayres, assistant chief engineer, Eaton Mfg. Co., Detroit, Mich.

Pittsburgh—March 23

Webster Hall Hotel. Mellon Institute Auditorium. 1954 SAE President William Littlewood.

St. Louis—March 9

Gatesworth Hotel. Dinner 6:30 p.m., meeting 8:00 p.m. Aircraft Safety Problems—Jerome Lederer, director of Cornell Guggenheim Aviation Safety Center, and managing director of the Flight Safety Foundation, Inc. This is our Annual Students night. Joint meeting with IAS.

Southern Calif.—March 18 and April 15

March 18—Rodger Young Auditorium. Dinner 6:30 p.m., meeting 8:00 p.m. Equipment Maintenance in Small Fleets—LaVerne Morgan, manager of the Edward R. Bacon Co., Oakland, Calif.

April 15—Rodger Young Auditorium. Dinner 6:30 p.m., meeting 8:00 p.m. Three Hands Cowboy—Julius Gaussoin, president, Silver Eagle Co., Portland.

Southern New England—April 6

Hartford Golf Club. Dinner 6:45 p.m., meeting 8:00 p.m. Turbojet Experience in Korea—James D. Clark, Bureau of Aeronautics, Washington, D. C.

Texas Gulf Coast—March 12 and April 2

March 12—Ye Olde College Inn, Houston, Texas. Dinner 6:00 p.m., meeting 7:30 p.m. Rear Axle Developments—Speaker to be announced.

April 2—Tailoring Modern Fuels for the Diesel Engine—E. A. Desmond, Research Laboratories, Ethyl Corp., Detroit, Mich.

Twin-City—March 10

Solarium Room, Curtis Hotel. Dinner 6:30 p.m., meeting 8:00 p.m. Development of Ramjet Power—J. W. Braithwaite, assistant chief aerodynamicist, Marquardt Aircraft Co., Van Nuys, Calif.

Western Michigan—March 16

Bill Stern's Steak House, Muskegon, Mich. Dinner 7:00 p.m., meeting 8:00 p.m. From Art to Science in Engine Testing—A. E. Cleveland, section supervisor, engine engineering department, Ford Motor Co., Dearborn, Mich.

Williamsport—April 5

Moose Club. Dinner 6:45 p.m., meeting 8:00 p.m. The Preignition Problem—Donald R. Diggs, mechanical engineer, E. I. duPont de Nemours.

TECHNICAL COMMITTEE *Progress*

SAE Group Sets Out to Reduce The Tribe of Aircraft Servomotors

THERE are too many different strains in the tribe of precision servomotors being used in aircraft navigational, radar, fire-control, and computing systems. That's the way the aircraft industry feels. So at the Aircraft Industries Association's request, an SAE committee has agreed to work toward standardizing these "muscles" that act on intelligence fed to them.

SAE Committee A-2 on Aircraft Electrical Equipment was the group asked to do the job. And it set the machinery in motion at a Jan. 27-28 meeting.

There, an A-2 Servomotor Panel established the groundwork for a standardization program. It decided to consider all A-C (400 and 60 cycle) and D-C servomotors of approximately 1/10 hp. These servomotors were described as units with a high torque-to-inertia ratio and a low efficiency as compared to power motors.

All too often, it seems, when one of these "muscles" is needed to do a particular actuating job, one more slightly different member is added to the servomotor clan. The panel hopes to apply the brakes to this practice.

To work toward this and other goals, the panel set up four subgroups whose efforts will be aimed at promoting standardization of (1) physical dimensions, (2) tests and test equipment (both A-C and D-C units), (3) terminology and nomenclature.

Serving on the physical dimension group are C. L. Kennedy, Sperry Gyroscope, Chairman; V. E. Hagen, Eclipse-Pioneer; R. R. Smith, Westinghouse; and K. Maples, Doelcam Corp.

The A-C performance group includes R. N. Brown, Kearfott Co., Chairman; R. Harris, Ketay Mfg. Corp.; D. W. Bloser, Transicoil Corp.; and E. Aha, Ford Instrument Co.

Members of the D-C performance group are J. W. Taylor, General Electric, Chairman; P. F. Bechberger, Eclipse-Pioneer; K. Maples, Doelcam Corp.; and R. C. Bohl, John Oster Mfg. Co.

Besides Chairman W. E. Garner of Westinghouse, the Terminology and Nomenclature group will include another member of the panel.

Technishorts . . .

CROSS-INDEX OF SPECS—Chemically equivalent ferrous and nonferrous metal specifications issued by various standardization organizations are cross-indexed in a recently issued volume. SAE Aeronautical Materials Specifications as well as standards from SAE Handbook are included.

The volume is Handbook DSMA H1, issued by the Defense Supply Management Agency. Title is "Cross-Index of Chemically Equivalent Specifications and Identification Code (Ferrous and Nonferrous Alloys)." It was developed by an Army-Navy-Air Force group in cooperation with General Motors' engineering staff.

Copies of this 320-page, 7¾ × 10¼-in. book are available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. at $1 per copy.

NEW SCOPE AND NAME—Scope of the SAE Hydrodynamic Drive Committee has been enlarged to cover all types of transmissions, including automatic and power shift designs. Also, to agree with the scope, the group's name has been changed to SAE Hydrodynamic Drive and Transmission Committee.

CRC Releases Four New Reports

THE following Coordinating Research Council reports have been released for distribution and are available from SAE Special Publications Department, 29 West 39th Street, New York 18, New York.

(This is a complete list of CRC reports released since publication of the listing of CRC reports on page 102 of the November, 1953, SAE Journal.

Lubricants

Engine Oil

CRC-273—Outboard Motors and their Lubrication (3/52) Priced $1.50 to SAE members; $3.00 to nonmembers.

Motor Fuels

Detonation—Full Scale

CRC-274—Octane Number Requirement Survey, 1952 (3/53) Price $4.00 to SAE members; $8.00 to nonmembers.

Aviation Fuels

Detonation—Full Scale

CRC-275—Determination of Knocking Characteristics of Aviation Fuels in

Full-Scale Aircraft Engines, (1/51) Price is .50 to SAE members; $1.00 to nonmembers.

Diesel Fuels

CRC-276—Front-End Volatility of Diesel Fuels (10/52) Price is $4.00 to SAE members; $8.00 to nonmembers.

License Plate Standard Developed by SAE Group

AN SAE standard size license plate has been approved by the Technical Board. The standard was developed by committees of the Automobile Manufacturers Association, the American Association of Motor Vehicle Administrators, and SAE. Adoption of such a standard size plate is said to offer advantages to the vehicle owner, enforcement agencies, and vehicle manufacturers.

The standard, to be published in the 1954 SAE Handbook, calls for a plate 6 in. high by 12 in. long. It specifies 9/32-in. diameter holes for attaching bolts located on 7-in. centers. The standard suggests that for best legibility and contrast in reflectivity, the numbers and symbols be in a light color on a dark background, or vice versa.

The SAE standard is essentially the same as the standard for a 6×12-in. plate recently adopted by AAMVA.

The gains to be realized from such a uniform plate size are said to be as follows:

- **For the car owner:** Theft protection, easier car maintenance, improved appearance, and lower cost brackets and frames.
- **For administration and enforcement agencies:** Better mounting, better protection, easier legibility, lower cost plates, and better illumination.
- **For car manufacturers:** Simplifies design, saves cost, permits simpler and more rugged brackets that can be incorporated in body rear deck, and allows provision for proper illumination.

The SAE committee which helped develop this standard was organized for this one purpose and has been disbanded. Serving on it were the following men: W. L. Cross, Jr., Connecticut Department of Motor Vehicles; A. W. Devine, Massachusetts; H. K. Gandelot, General Motors Corp.; W. L. Groth, Virginia; G. E. Keneipp, District of Columbia; W. F. Sherman, AMA; and D. D. Blanchard, SAE.

V. A. Crosby Is 1954 ISTC Chairman; ISTC Panels Also Have New Chairmen

VICTOR A. Crosby has been named chairman for 1954 of the SAE Iron and Steel Technical Committee. Crosby, who is a metallurgical engineer for Climax Molybdenum in Detroit, has been active in ISTC work for years and was SAE vice-president for the engineering materials activity in 1952.

Crosby

The four ISTC panels also have new chairmen. They are:

Panel A—Steel Producers
J. G. Morrow, chairman
P. R. Wray, vice-chairman

Panel B—Castings
R. J. Wilcox, chairman
Ralph Clark, vice-chairman

Panel C—Automotive
Joseph Gurski, chairman
Anthony Wagner, vice-chairman

Panel D—Tractor and Earthmoving
F. T. McGuire, chairman
M. L. Frey, vice-chairman

Morrow is a metallurgical engineer for the Steel Co. of Canada. Wilcox is technical director of the Michigan Steel Casting Co. Gurski is supervisor of materials and processes, manufacturing research department, at the Ford Motor Co. McGuire is manager of the materials engineering department at Deere & Co.

Wray is metallurgical engineer with the U. S. Steel Co. Clark is service manager, Electro Metallurgical Division, Union Carbide and Carbon Corp. Wagner is chief metallurgist of the Hudson Motor Car Co. Frey is assistant to the general works manager of the Allis-Chalmers tractor division.

Morrow

Wilcox

Gurski

McGuire

Getting the Most From Automotive Spur Gears

John A. Halgren, International Harvester Co.

Excerpts from talk "Notes on Automotive Gears" presented to Panel D of SAE Iron & Steel Technical Committee, Sept. 16, 1953

WE all know that gear teeth do not ordinarily break or pit or wear because they are understressed. They have to be overstressed in order to fail. Overstressing can result from a number of causes:

1. The original design may be entirely inadequate.
2. Dimensional tolerances may be excessive.
3. The gears may be machined inaccurately.
4. The mountings may be insufficient.
5. Unnecessarily high stress concentrations may be present.
6. The beneficial effects of certain machining practices, such as crown cutting, involute modifications, and tip relief may not be used to advantage.
7. The material strength may be inadequate.
8. The material and heat-treatment may cause excessive distortion and unfavorable residual stresses.

What influence does each of the above factors have in the overall performance of gears? Which is the most important? The following discussion will attempt to throw some light on these factors.

Suppose it were possible to manufacture gears with perfect involute actions and accuracy, and suppose all materials were perfectly rigid. Then the dynamic load on each tooth would be essentially equal to the static load at all speeds; the strength of any specific gear would depend upon its metallurgy, surface finish and root fillet size more than any other factors.

We all realize that it is impossible to manufacture automotive gears to this specification. Gears and gear mountings must have reasonable dimensional tolerances which can be met by the use of present-day machine tools and by the use of steels and designs which give minimum distortion after heat-treatment. The extent of these dimensional tolerances and the degree of rigidity in the gears and mountings determines the amount by which the dynamic load will exceed the static load. In fact, the resulting effect of these factors on the load carrying capacity of gears often far surpasses the effect of such metallurgical factors as type of steel used in the gears.

Preventing Pitting

The condition of high dynamic load with small static load apparently can be the cause for pitting failures experienced in timing gears, where static loads are usually very nominal and noise level is important. In such applications the use of finer pitch gears often proves helpful. In fine pitch gears, more teeth are in contact at any given time, thus compensating for some errors in tooth profile. Finer pitch gears have greater resistance to pitting.

A practical example is the case of some 10-pitch timing gears with 1-in. face width which failed by pitting after a relatively short period of dynamometer operation. The same gears, when cut to 16-pitch tooth size, gave satisfactory dynamometer performance even when the face width was reduced in half.

Increasing the hardness of coarser pitch timing gears by heat-treatment after cutting aggravates involute errors; it subjects the harder teeth to correspondingly higher dynamic loads.

It is important for metallurgists to know that there are certain methods of machining gears to partially compensate for inaccuracies and deflections in the gears themselves and in their mountings. One method which is used widely nowadays is to crown cut one of the gears so that initial loading takes place near the center of each tooth. The correct amount, or dosage, of crown cutting can increase the strength of gears considerably, both in bending and in compression. Overdosage, of course, may result in no improvement or may even lower the strength of the gears.

Crown cut gears are reported to run quieter than standard cut gears. This is further evidence of better loading conditions, since noise means interference and interference breeds short life or excessive wear in gears.

Involute profile modifications are used to compensate for the elastic bending which occurs when teeth are loaded. Such modifications prevent interference as teeth enter into mesh.

Tip relief also is used to prevent interference as teeth enter mesh. Certain steels and methods of heat-treatment cause the tip of gear teeth to expand disproportionately to the rest of the profile. Induction hardening does this ordinarily. The cure is to machine tip relief into the involute profile so that the final profile after heat-treatment will be satisfactory.

It should be emphasized that the performance of gears is related only to their geometry after heat-treatment—not to the geometry of the green gears. Years ago gears used to be machined to the finish geometry which was desired, and metallurgists were criticized when the heat-treated gear varied from this geometry. Today we recognize that dimensional changes occur during heat-treatment. With good heat-treating practice and use of proper steels, these changes will be constant enough so that we can live with them by adjusting the original geometry to allow for them.

The use of full fillet radii at the roots of gear teeth promotes maximum strength under bending fatigue loading. Such fillets reduce working stresses at this location.

In clash face gears, the nose of the rounding tool should generate a fillet which blends in with the root fillet of the tooth. Lack of fillets on the nose rounding tool results in high local stress concentrations at the rounded end.

Fig. 1 illustrates the extent of improvement in strength that can be gained by using some of the factors which have been mentioned. It shows the results of some dynamometer tests made on case carburized and induction hardened seven-pitch spur gears in our laboratory.

Some of the original carburized gears would not quite carry a bending stress of 35,000 psi, as calculated by a modified Lewis formula used by several of our divisions. With geometric changes —no significant changes in heat-treatment or steel—the endurance limit was increased to 55,000 psi, which corresponds to a percentage increase of 55%.

There is no doubt that this increase could be made larger yet by further refinements in geometry. You will

note that the endurance limit of induction-hardened carbon steel gears under bending loads has reached that of case carburized alloy steel gears in these tests. Under compressive loads, the induction hardened gears have not been quite so strong as carburized gears.

How Much Case Depth

Whenever metallurgists discuss gears, the question of proper case depth and core hardness seems to arise. Such discussions always seem to result in uniformity of opinion when the discussion group is limited to one metallurgist. A satisfactory agreement on what constitutes case has not been entirely resolved.

Metallurgists realize that all steels which are carburized to the same carbon gradient will not quench out to identical hardness levels along this gradient in carbon content. Some have leaned toward the view that the distance from the surface at which the material drops below 50 Rockwell C is the important consideration. Since gear performance depends upon material strength at the surface and below the surface—at least within reasonable proximity of the surface, the use of minimum hardness specification at a given depth for measuring case depth has certain merits.

To find out what is actually required in depth of case and in core hardness, we recently made a photoelastic study of the seven-pitch spur gears previously mentioned.

In this study, we determined the relationship between surface and subsurface stresses at the roots of the teeth under a bending moment applied at the pitch line. Shear stresses at the pitch line were analyzed in depth by the use of standard Hertzian formulas. The results are shown on the left side of Fig. 2.

Note that the bending stress in these seven-pitch spur gears decreases very rapidly below the surface and is only 27% of the surface stress at 0.040 in. below the surface. The shear stress at the pitch line reaches a maximum at 0.010 in. depth and then falls off with increasing depth, but not quite so rapidly as the bending stresses.

The chart on the right of Fig. 2 represents a rough approximation of the hardness gradients required at the pitch line and root fillet of these spur teeth to insure that fatigue failure can occur only at the point of maximum stress.

These gradients were determined by:

1. Assuming a hardness of 57 Rockwell C and tensile strength of 304,000 psi at the point of highest stress.
2. Multiplying this tensile strength by the relative percent of stress at various distances under the surface.
3. Converting these tensile strengths back to hardness figures.

For sake of simplicity the endurance limit was assumed to be directly related to tensile strength. Also, the effect of residual stresses and surface condition upon endurance limits was neglected. Actually the hardness gradient for bending should have a steeper slope near the surface because of the surface conditions at the roots of the teeth. In other words the subsurface hardness required for bending should be even less than that shown by the line on this chart.

The important factor brought out by this chart is that depth of hardness or case at the root can be shallow insofar as bending strength is concerned. However, when shear stresses are high and pitting is encountered, the depth of hardness or case in the vicinity of the pitch line must be considerably greater than that required for bending strength at the root.

Fortunately, the physics of case hardening and of most induction hardening cycles and the geometry of gear teeth usually combine to make the depth of hardness at the pitch line greater than at the root.

Examination of a number of gears with various heat-treatments has indicated that all of them exceeded the sub-surface hardness gradients shown in this chart when the surface hard-

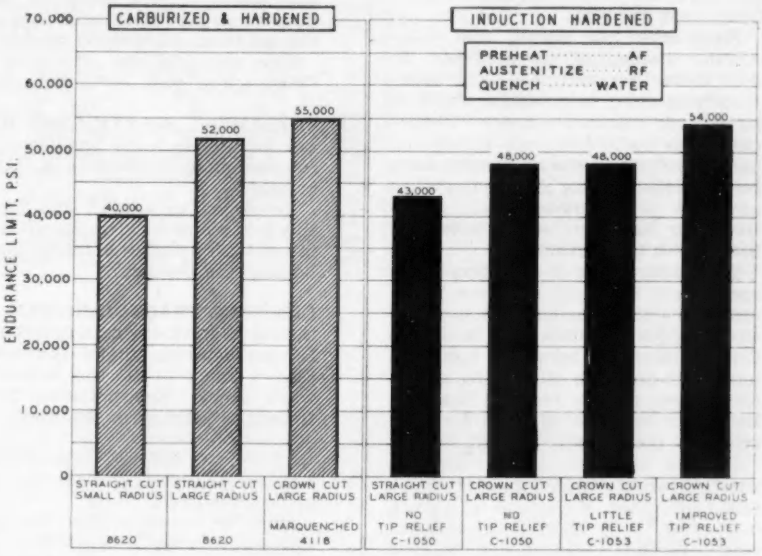


Fig. 1—These fatigue test comparisons show that the strength of seven-pitch spur gears can be materially improved by varying the machining method

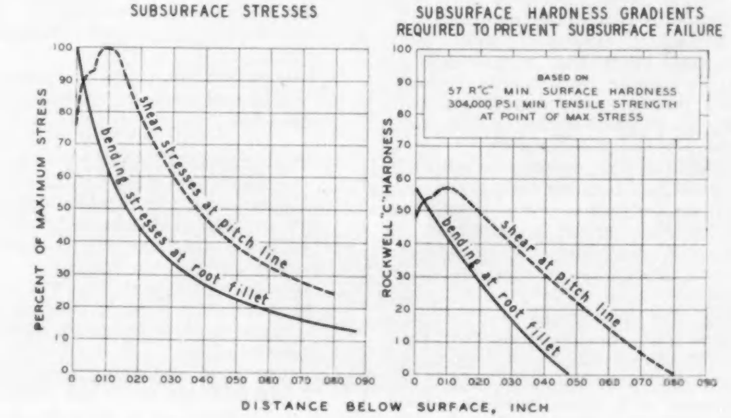


Fig. 2—Subsurface stresses found in a photoelastic investigation of seven-pitch spur gears to determine required case depth and core hardness

ness of 57 Rockwell C was met. The fact that they exceeded these hardness gradients is not too surprising, since they were heat-treated to meet a minimum specification which exceeded this gradient considerably. Failure to meet this surface hardness has resulted in reduced endurance limit. No specific studies have been made on gears which meet this surface hardness, but do not meet the sub-surface hardness gradients.

The present practice used in the induction hardening of gears develops more depth of hardening at the pitch line than at the root of gear teeth. When induction hardening of gears was first introduced, the question of contour hardening over non-contour hardening was a serious problem, since two different types of expensive equipment were involved.

Experience has shown that non-contour hardening, as produced by 9600 cycle frequency, has been satisfactory in many cases—particularly in large pitch automotive gears. Combinations of audio frequency preheating and radio frequency austenitizing have been satisfactory for most automotive gears of transmission size. Radio frequency has been used successfully for smaller pitch gears.

The performance of induction hardened gears increases with the hardness at the pitch line and root, provided that residual stresses are favorable. One difference between induction hardening and case carburizing is that the former process requires that the hardening cycle be adjusted for each gear part number for optimum results.

One of the best heat-treatments which have been developed for gears has been given the name of "marquenching." It differs from martempering in that the core of the gear transforms during the quench, leaving the case to transform during air cooling from the quench. Gears can be batch quenched by this method with sufficient freedom from distortion that individual press quenching has been eliminated. Load-carrying abilities of transmissions equipped with marquenched gears has been increased 15% or more. Equivalent dynamometer results have been obtained on gears made from steels of the 4100, 8600, 9400 and 50B00 series.

Controlled shot peening of gears can increase their bending fatigue strength approximately 25%. Where required performance cannot be obtained by geometric and metallurgical changes, the use of shot peening may be warranted.

The road to improved gear performance is not a one-way street for metallurgical investigators only. The road has several other main highways for designers and manufacturers. Each gear problem requires an adequate analysis to determine which highway or highways require further surveying.

These reports have been approved recently by the SAE Technical Board . . .

SINTERED METAL POWDER PARTS—A new SAE General Information Report on this subject outlines seven SAE types. Types 1-4 are for bearings. Types 5-7 are for structural parts. Chemical compositions and physical properties are listed for each type. Both copper and iron base sintered parts are covered.

BRAKE-DRUM MOUNTING: A new SAE standard covers mounting dimensions for large brake drums used on off-highway and other heavy construction and industrial equipment.

The recommendations in this standard are intended to govern only the attachment pilot and bolt circle dimensions. Details of attachment (rivets, bolts, or other means and consequent hole dimensions and tolerances) are not covered because they are considered items of specific design.

This standard was developed by Subcommittee X of the SAE Construction and Industrial Machinery Technical Committee.

IMPLEMENT SAFETY-LAMP BRACKET: Joining the SAE standard on an electrical breakaway connector for farm tractors is a companion piece covering a standard farm-equipment safety-lamp bracket.

Developed by a joint FEI-SAE Tractor Lighting Subcommittee, this new standard gives specifications for (1) a standard breakaway bracket for holding a safety lamp, and (2) a standard socket for holding the bracket.

CRAWLER TRACTOR NOMENCLATURE: Names of major parts of industrial track-laying tractors are outlined in a new SAE standard. Besides depicting major powerplant, power-train, chassis, and accessory components, this nomenclature also shows six basic type track shoes. Subcommittee XIII of the SAE Construction and Industrial Machinery Technical Committee prepared this standard.

RATING WORM-GEARED WINCHES: A new SAE standard tells how to rate worm-geared winches . . . and defines the five types of rating winches carry.

Winches to which this standard can be applied are those with worm-geared single or multiple horizontal drums (usually equipped with winch heads) that work off a two-directional engine power take-off.

The SAE Transportation and Maintenance Technical Committee developed this document.

ROLLER AND SILENT CHAINS: As one of the sponsors of ASA Sectional Committee B29 on Transmission Chains and Sprocket Teeth, the Society has approved these two proposed American Standards:

1. Double-Pitch Power Transmission Roller Chains and Sprockets.
2. Double-Pitch Conveyor Roller Chains, Attachments, and Sprockets.

TIRE CHAIN CLEARANCE: A new SAE general information report can aid commercial-vehicle designers in their selection of body, frame, and wheel-housing clearances that permit use of tire chains. As a further guide to designers, this report also suggests the minimum bogie spacing that will permit using chains on both axles.

The dimensions outlined in this designer's guide are based on recommendations of the Tire and Rim Association and the Chain Institute. They cover clearance for chains over the tire only. Allowance must be made for spring deflections in determining fender clearance.

The Load and Dimension Limitations Subcommittee of the SAE Truck and Bus Technical Committee worked up this report.

Filter-Test Subcommittee Continues To Refine Its Proposed Test Method

INTENSIVE detective work on the part of the Filter Test Methods Subcommittee has disclosed the reason for poor correlation of test results obtained with its proposed test method and contaminant:

It appears that the gear pump in the system was grinding the contaminant finer and finer. This made it harder and harder for successive filter elements to remove the test contaminant. Substituting another type of pump seems to cure the trouble.

Culprit Pump Mixes Oil, Dirt

In the proposed procedure, the pump is used to mix fresh oil with concentrated dirt stock compacted by Pontiac Laboratories from collected crankcase drainings. The stock is known as SOFTC No. 1—the letters referring to "standardized oil filter test contaminant."

Fig. 1 shows a test set-up typical of those used in a series of trials of the procedure by the laboratories with which various subcommittee members are associated. The gear pump appears in the lower left-hand corner. It maintains the dirt-in-oil dispersion from which the initial charge and subsequent additions are drawn. It operates throughout the test.

At intervals during the test, dirt stock is drawn from the "dirt stock concentrate agitator" system and mixed in the "contaminant add agitator" system with oil drawn from the oil sump supplying the filter. The add mixture is placed in the quadrant dumper, which feeds it into the sump of the filter test stand.

Pentane Insolubles Measured

Filter efficiency is measured by determining the pentane insolubles in oil samples withdrawn periodically from the filter sump.

Various labs ran successive 100-hour tests on three elements on test stands like the one shown. The results agreed reasonably well on the first filters tested by the labs. But six out of seven labs found that results on their second and third filters were progressively worse. And—possibly because the dirt had circulated through the gear pump longer between tests in some labs than in others—the labs didn't get comparable results on second filters tested or on third filters.

Subcommittee sleuths deduced at a meeting in November that grinding was influencing test results. So several of them substituted other types of pumps for the gear pumps and reran their tests. Correlation was much better.

To substantiate this evidence, the subcommittee at its January 12 meeting planned further tests, the results to be reported at a meeting set for March 3. Serving on the Subcommittee are W. A. Hunter, chairman, Chrysler; R. Beckett, Walker Mfg.; R. L. Bowers, AC Spark Plug; S. L. Earle, U. S. Naval Engineering Experiment Station; F. B. Hunt, Detroit Arsenal; W. S. James, Fram; E. D. Kane, Cuno Engineering; J. P. Kovacs, Purolator; C. J. Lauer, AC Spark Plug; R. J. Pocock, Ford; H. R. Otto, Purolator; and W. Trautman, Walker Mfg.

The group functions as a subcommittee of the SAE Engine Committee.

DURING the past 12 months, over 4500 hours of test running have been expended on the work of the Filter Test Methods Subcommittee by the laboratories with which its members are connected. They are the laboratories of:

- **AC Spark Plug Division, GMC**
- **Chrysler Corp.**
- **Cuno Engineering Corp.**
- **Detroit Arsenal**
- **Ford Motor Co.**
- **Fram Corp.**
- **Purolator Products, Inc.**

The Subcommittee's goal—which members feel they are now approaching—is development of a procedure for determining oil filter element efficiency which will give reproducible results and good agreement between labs.

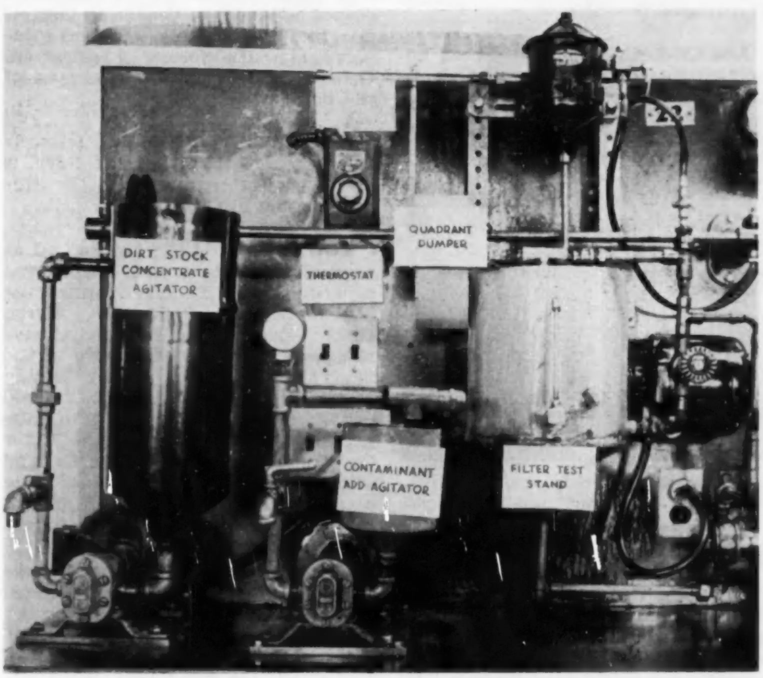


Fig. 1—Fram set-up for carrying out tests of oil filter elements according to procedure proposed for standardization. This set-up is typical of those used by all seven labs cooperating on the test program

About SAE

T. B. RENDEL has been appointed assistant to the vice-president, refining, of Shell Oil Co., C. E. Davis. He will be responsible to management for facilitating the company's relationships and participation in the work of various technical associations. Rendel is currently chairman of the SAE Publications Committee and also of the Coordinating Fuel Research Committee of the Coordinating Research Council.

Rendel

Rozner

J. J. ROZNER is now a vice-president of the Parkersburg-Aetna Corp., a merger of The Parkersburg Rig and Reel Co., Parkersburg, West Virginia, and Aetna Ball & Roller Bearing Co., Chicago. Rozner was vice-president in charge of operations of Aetna. The business of the two concerns will be conducted as divisions of the West Virginia corporation. Parkersburg Rig and Reel manufactures equipment used in the production, processing and storage of petroleum products. Aetna manufactures ball and roller bearings and related products.

LELEAND E. WELLS has been appointed director of research and engineering for the recently formed Exide Industrial Division of The Electric Storage Battery Co., Philadelphia. He formerly was chief engineer for the company. Wells is author of the storage battery section in the latest Collier's Encyclopedia.

Wells

Ford

HENRY FORD II, president of Ford Motor Co., has been awarded the 1954 Gold Medal of Achievement by the Poor Richard Club of Philadelphia. He was cited as, " . . . a man who nobly served the nation in critical war years, devoting himself and his vast organization to the production of vital equipment that delivered mighty aids in the attainment of victory and peace. . . ."

M. W. BOLSTER has been transferred to Shell Oil Co.'s Cleveland Division office. Bolster was with Shell at Grand Rapids, Mich., as district industrial salesman.

F. G. Borowsky

A. G. Borowsky

F. GORDON BOROWSKY has been elected president of George K. Garrett Co., Inc., Philadelphia. He was vice-president. The former president, **A. G. BOROWSKY** is now chairman of the board.

BERGER VELANDER, formerly with the Department of the Navy, is now a project engineer with the Allison Division of GMC, Indianapolis.

ERWIN F. COLLINS has retired as head of the metallurgical engineering department of Bendix-Westinghouse Automotive Air Brake Co., Elyria, Ohio. "Doc" Collins has had thirty-five years of varied experience in the field of metallurgy. Before joining Bendix-Westinghouse in 1946, he held metallurgical positions with Continental Motors Corp., Packard Motor Car Co., Maxwell Motor Car Co. and Willys-Overland Motors, Inc. He plans to play golf and experiment with medicinal herbs in Medford, Oregon.

WILLIAM J. McCLURE has become regional manager for Davey Compressor Co. of Kent, Ohio. His territory includes Oregon, Washington, Idaho, Montana, Alberta, British Columbia, Yukon territory and Alaska. His headquarters are in Seattle. McClure is presently serving as treasurer of the Northwest Section.

COL. WILLARD F. ROCKWELL, chairman of the board of Rockwell Mfg. Co. and Rockwell Spring and Axle Co., has been appointed to the newly-formed Pennsylvania Commission on Intergovernmental Relations. Col. Rockwell is one of three Pittsburghers on the 22-member commission which has been established for study and recommendations on existing overlapping and duplicating functions of federal and state government.

C. W. CHOROMANSKI, executive vice-president of Rowe Methods, Inc., Cleveland, has announced that Rowe Methods has been appointed exclusive distributor in Northeastern Ohio by the Mult-A-Frame Division, Ainsworth Mfg. Corp., Detroit. Ainsworth manufactures a complete line of adjustable racks designed for such items as bars, cables, reels, packages, coils, and a wide variety of other products.

Firestone

Trainer

RAYMOND C. FIRESTONE and **J. E. TRAINER** have been elected to the newly-created positions of executive vice-president of The Firestone Tire & Rubber Co. Raymond Firestone has been vice-president in charge of research and development since 1949 and Trainer has served as vice-president in charge of production since 1940.

ROBERT HARVEY KOHR is now a research engineer with the Research Laboratories Division of GMC. He was previously an assistant project engineer for the Holley Carburetor Co., Detroit.

Members . . .

D. H. GREEN has been promoted to the position of product manager, automotive products, for National Carbon Co., a division of Union Carbide and Carbon Corp., New York. In this capacity he functions for the general management in the coordination of the technical development, service and application engineering of the company's automotive products.

F. A. GUNDLACH has succeeded Green as manager of the automotive engineering department of National Carbon. Gundlach was assistant manager of the department.

N. B. NELSON has announced the opening of a new office in Detroit for the Plastic and Rubber Products Co., Los Angeles. Nelson is district manager for the company in Detroit.

RAYMOND SZYMANOWITZ has been appointed executive vice-president of Acheson Industries, Inc., Newark, N. J. Szymanowitz formerly served as vice-president.

Szymanowitz

Appel

WALTER D. APPEL has opened an office as engineering consultant, at Orchard Lake, Mich. He was formerly director of engineering of Ford International and chief engineer of General Motors Overseas Operations.

Prior to that time he was chief engineer of Vauxhall Motors Ltd. in England and technical director of Adam Opel A.G. in Germany, where he directed the design of European light cars and trucks.

ROBERT J. MILLER is now with Pratt & Whitney Aircraft, Division United Aircraft Corp., East Hartford, Conn.

Black

Hummel

JAMES J. BLACK has been named vice-president of engineering, Trailmobile, Inc., Cincinnati. He was chief engineer, the position now held by **WILLIAM R. HUMMEL.** Hummel was executive engineer.

JOHN C. HOLLIS, manager of the Administrative Division, SAE, was speaker at the February meeting of the ASME's Metropolitan Section. His talk was, "Engineering your Personal Advancement." Hollis is associated with the Advertising Club of New York as lecturer, and is a leader at the Man Marketing Clinic.

JOSEPH GESCHELIN, Detroit editor of "Automotive Industries," will be one of the speakers at the annual meeting of the Metal Powder Association which wil be held in Chicago April 26, 27, and 28th.

The subject of his talk will cover the expanding field of application of metal powder parts in the automotive industries.

CHARLES S. FISHER announced the change of name of the Goodspeed-Detroit Co. to the Fisher-Detroit Co., 2832 East Grand Boulevard, Detroit. Fisher is the owner of the company which is a manufacturers' agency for machinery, tools, and factory equipment.

Franz

Nutt

DR. ARTHUR NUTT has been named vice-president, engineering, of the newly-consolidated Lycoming Division, Avco Mfg. Corp., Stratford, Conn. **HARRY J. GRAHAM** is chief engineer. Dr. Nutt was previously director of engineering and contracts of the Bridgeport-Lycoming Division, and Graham was chief engineer. Dr. Nutt was SAE's president in 1940.

DR. ANSELM FRANZ is vice-president, turbine engineering, at the new division. He was formerly director of research and development, Lycoming-Spencer Division.

ROY C. INGERSOLL, president of Borg-Warner Corp., Chicago, has announced the establishment of a market research department of Borg-Warner. Activities of the new department are to supplement and augment the market research operations of the corporation's various divisions.

WILLIAM W. MOSS has been appointed assistant chief pilot, training of the Atlantic Division of Pan American Airways.

R. A. STRANAHAN, JR. has been named executive vice-president of the Champion Spark Plug Co., Toledo. He was a vice-president.

Stranahan

Eames

W. R. EAMES has been named general manager of the Pump Division, Detroit, of the Eaton Mfg. Co., Cleveland. Eames was formerly chief engineer and assistant to the general manager of the division.

NORMAN GECO has been appointed to the newly-created position of Western District sales manager for the Mechanical Seal Division of Gits Bros. Mfg. Co., Chicago. He was field service engineer, Crane Packing Co., Morton Grove, Ill.

Mott

Daisley

F. H. MOTT has been elected administrative vice-president in charge of all Eaton Mfg. Co.'s plant operations in Michigan. **R. H. DAISLEY** has been elected administrative vice-president in charge of all Eaton plants in Ohio, Kenosha, Wis., and London, Ontario. Mott was general manager of the Pump Division of Eaton in Detroit, and Daisley was formerly vice-president of manufacturing.

RALPH SIEMERS has been transferred from the Cadillac Division of GMC to the Allison Division in Indianapolis. He is assistant to the head of aircraft engine testing operations. He was general foreman of the engineering lab, Cadillac Motor Car Division, Cleveland tank plant.

T. B. DOE, JR. has been advanced to the Manufacturing Division of Vickers, Inc., Detroit. He will be responsible for process engineering, tool control, and allied activities for all Vickers products being produced at the Detroit, Omaha, and Joplin plants. He was manager of aircraft products, Sales Division, for Vickers.

THOMAS O. NEWBY is now a test engineer at the Allison Division of GMC in Indianapolis. He was with the Department of the Army, Army Chemical Center, Md.

GEORGE S. PIROUMOFF, who has been with Brockway Motor Co., Inc. of Cortland, N. Y., for the last twenty-five years, has retired as president of the company to gain, "a badly needed . . . rest." However, Piroumoff will be available to the organization as a consultant.

JAMES R. DAVIS has joined Fairbanks, Morse & Co. in Beloit, Wis.

MAX M. ROENSCH has been named director of laboratory tests at Chevrolet Motor Division, GMC, by **E. N. COLE**, chief engineer. Roensch was associated with Ethyl Corp. as staff assistant to the associate director of research. He has researched engine-fuel relationships and delivered several papers to SAE on the subject. Roensch was SAE vice-president for diesel engine activity in 1949. Currently he is active on several SAE and CRC committees.

Roensch

Potter

D. A. POTTER, formerly chief engineer at the South Wind Division of Stewart-Warner Corp., Indianapolis, has been named to the newly-created position of manager of aircraft and military products. He will perform combined functions of chief engineer and of the general sales manager related to aircraft heater and heat transfer equipment and military vehicle heater sales.

HARLAN D. FOWLER is now an aeronautical consultant specializing in the field of boundary layer control. Special emphasis will be on the practical aspect of power sources, economy of operation, and design problems associated with high lift, low drag, and stability as affected by the boundary layer control systems. His address is Alban Towers, 3700 Massachusetts Avenue, Washington 16, D. C.

Fowler was previously specialist of aeronautical science, Department of the Air Force at the Wright-Patterson Air Force Base, Dayton, Ohio. He is also the author of "The Fowler Flap."

ELMER LATSHAW, formerly technical engineer for ACF-Brill Motors, Philadelphia, is a mechanical engineer at the Naval Air Material Center, Philadelphia.

DESLE O. H. MILLER, previously sales engineer with the French & Hecht Division, Kelsey-Hayes Wheel Co., Davenport, Iowa, is now sales engineer with the Chicago Rawhide Mfg. Co., Peoria, Ill.

J. N. McHATTIE has been appointed technical officer to the Society of Motor Manufacturers and Traders, London, England. He was technical editor of "Motor Trader," Trader Publishing Co., Ltd., London, England. He is the author of two volumes of "Servicing Guide to British Motor Vehicles."

Lewis

Burkhalter

ROBERT P. LEWIS has been appointed director of engineering and **ROBERT R. BURKHALTER** executive engineer of the Spicer Division of the Dana Corp., Toledo, Ohio. Lewis was executive engineer of the division, and Burkhalter was his assistant. Lewis was chairman of the SAE Axle Committee which analyzed and investigated captured German, Italian, and Japanese enemy equipment.

HENRY H. WAKELAND is now a project engineer for Sperry Gyroscope in New York. He was a research assistant at Purdue University.

JOHN K. APPELDOORN, who has been a research engineer for the Standard Oil Development Co. in Linden, N. J., is now head of the additives section in the Esso laboratories, Research Division.

DR. R. E. WILSON, chairman of the board, Standard Oil Co. (Indiana), was principal speaker at the opening luncheon of the 15th Annual Meeting of the Private Truck Council of America, Inc. (formerly the National Council of Private Motor Truck Owners, Inc.), last January 28. His subject was: "Strategy for True Liberals."

HENRY ROWOLD, chairman of the Council's Public Relations Committee, led a session devoted to "Public Relations for Private Truck Operators," and **ROBERT CASS**, assistant to the president, White Motor Co., Cleveland, was moderator of a panel, "Manufacturer Meets Consumer." Cass was SAE's president in 1953.

Other SAE members on the panel were: **J. J. BLACK**, vice-president of engineering, Trailmobile, Inc., Cincinnati; **C. W. ELDER**, sales technician, Ford Motor Co., Dearborn, Mich.; **J. J. ROBSON**, manager, tire engineering and development, The Firestone Tire & Rubber Co., Akron, Ohio; **R. C. WALLACE**, executive engineer, Diamond T Motor Co., Chicago; and **GLENN W. JOHNSON**, supervisor, producer relations, motor transportation, Bowman Dairy Co., Chicago.

CHARLES L. FLEMING, JR. has become director of the Research Division of the Standard Oil Development Co., central research and engineering affiliate of the Standard Oil Co. (New Jersey). He was formerly associate director. **JOHN G. McNAB**, formerly assistant director, became associate director.

A. J. LARRECQ has announced the change of name of Power Generators Ltd., Trenton, N. J. to Power Generators Inc. Larrecq is president of the company.

M. C. NEUL is associated with the Le Tourneau-Westinghouse Co. of Peoria, Ill., as a layout draftsman in the research and development department. He was chief draftsman for the Lavers Engineering Co. of Chicago.

DEAN E. BURLEIGH, chief administrative engineer and **VIRGIL ADAMSON**, administrative engineer, Beech Aircraft Corp., Wichita, Kansas, have received diamond-studded 20-year pins. They are among six of the oldest employees of the 21-year-old company.

LESTER J. HENDERSON has been appointed sales manager of the newly-created Industrial Division of The Weatherhead Co., Cleveland. He will direct selling activity for the Weatherhead line of industrial products: Ermeto tube connectors, heavy-duty hose and reusable couplings, and permanently attached hose assemblies used in industrial original equipment manufacture. Henderson was sales manager of the aviation department of Weatherhead in Euclid, Ohio.

Henderson

Schmitz

CARL E. SCHMITZ, vice-president and general sales manager of the Crane Packing Co. of Chicago, has been appointed director of the National Conference on Industrial Hydraulics for 1954. The Conference is sponsored by the Illinois Institute of Technology and the Armour Research Foundation and a group of technical societies.

WALLACE ZELLER is now general manager of Scribner & Lewis, Inc., Bridgeton, N. J. He was president of South Jersey Autos, Inc., Haddonfield, N. J.

Lindbergh Says . . .

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Col. Charles A. Lindbergh (left) being presented with Daniel Guggenheim Medal by Harry F. Guggenheim

COL. CHARLES A. LINDBERGH was awarded the 1953 Daniel Guggenheim Medal, jointly sponsored by ASME, IAS, and SAE, on January 25.

In his address of acceptance, Lindbergh noted that we have successfully achieved a mechanistic society; but we have neglected the basic needs of man. In developing this thesis, he said:

"Now, at the end of the first half century of engine-driven flight, we are confronted with the stark fact that the historical significance of aircraft has been primarily military and destructive. Our bombs have wiped out, in minutes, an inheritance of life and labor which centuries created.

"Aviation is having its greatest effect on the force-influence of nations, and factors of survival, while diplomatic relations are floundering in a strange new framework of power, time and space . . .

> "Survival has a time dimension which says that power consists of more than strength of arms. Short-term survival may depend on the knowledge of nuclear physicists and the performance of supersonic aircraft, but long-term survival depends alone on the character of man.

"Our scientific, economic, and military accomplishments are rooted in the human quality which produces them . . . While we concentrate on the tools of economics and war, we must not neglect the basic means of surviving, the basic reason for survival, man himself.

"What will this modern environment of ours create in the future character of man? Here, rather than in the atom is the power which will establish our wisdom and decide our fate. . . .

"During decades of industrial development, western man has taken himself for granted while he concentrated his attention on material creations. He now wakes rather suddenly to find his security dependent on the machine organization he has built, with his civilization threatened by its products.

"He comes to the increasing realization that he has not kept inward pace with his outward actions. . . .

"We have wiped out a city with a single bomb, but how can we use this fact to heighten our civilization? We build aircraft by the tens of thousands in our factories, but what will our factories build in the character of their personnel—not only in our generation, but in our children's, and their children's? We tie all countries close together, put each doorstep on a universal ocean; but how are we to direct these accomplishments to improve the basic qualities of life?"

New Deputy Assistant Secretary of Defense

SAE Past President **Dr. D. P. BARNARD**, of Chicago, research coordinator for the Standard Oil Company (Indiana), was appointed Deputy Assistant Secretary of Defense (Research and Development) on February 1. In this position, he is deputy to Donald A. Quarles, Assistant Secretary of Defense (Research and Development) whose office is responsible for advising the Secretary of Defense on military research and development matters, particularly with respect to planning the over-all program of the military departments and integrating it with the strategic objectives of the Joint Chiefs of Staff.

One of Dr. Barnard's immediate tasks is to serve as Chairman of certain of the coordinating committees composed of representatives of the military departments, and of the Office of the Assistant Secretary. The coordinating committees are supported by technical advisory panels which are made up of civilian scientists and engineers.

The coordinating duties of the office are conducted through 13 committees whose scopes of interest include piloted aircraft, guided missiles, ordnance, medical science, tanks and amphibious vehicles, and others. The technical advisory panels serve the office and the committees in the fields of aeronautics, atomic energy, biological and chemical warfare, electronics, fuels and lubricants, general sciences, materials, medical sciences, ordnance, personnel and training and research in certain special operations.

Dr. Barnard is on leave of absence from the Standard Oil Company (Indiana) during his appointment in the Department of Defense.

ROBERT T. MILLS is now a senior layout draftsman with Chevrolet Motor Car Division of GMC. Mills was a project engineer for the Cadillac Motor Car Division, GMC.

ROBERT A. WAGNER is with Hiller Helicopters, Inc., Palo Alto, Calif. He was formerly a chief engineer for the Aircraft Division of McCulloch Motors Corp., Los Angeles.

Spicer Celebrates 50th Anniversary

RALPH E. CARPENTER (right) is shown passing a medallion which commemorates the 50th anniversary of the Spicer Mfg. Division of Dana Corp. Carpenter, vice-chairman of the board of Dana Corp. who served as president until recently, gives the medallion to **J. E. MARTIN**, newly elected president. Spicer Mfg. was founded in a corner of a New Jersey printing press plant to manufacture universal joints for automobiles and trucks. The Division is now a supplier of major components for automobiles, trucks, buses, tractors, airplanes and railroad cars.

JEAN BORDEAUX, JR. is a chemical engineer for the R. M. Hollingshead Corp., Camden, N. J. He was a research engineer for Bray Oil Co., Los Angeles.

GEORGE W. PEKHAM, formerly with the Coca Cola Co., in charge of automatic control, is now with the Chattanooga Glass Co., Chattanooga, Tenn.

LOUIS PAUL ZETYE is now with the Paramount Engineering Co., Detroit. He was previously a body layout draftsman for the Hudson Motor Car Co., Harper Plant, Detroit.

ANTHONY F. SOLLA has joined the Hayes Aircraft Corp., Birmingham, Ala., as a designer "B". He was with Lockheed Aircraft as a designer "A".

ROY E. JORGENSEN, engineering counsel of the National Highway Users Conference, has assisted the Arizona Highway Department and the state's special Legislative Highway Study Committee in the development of a 10-year state highway program. Part of his recommendations include annual reappraisal and programming of construction to meet urgent needs in logical order of priority, based on the sufficiency rating records of the highway department.

JAMES S. WALKER has been appointed sales manager of a new division of General Motors Products of Canada, Ltd. The division has been formed to sell, distribute and service passenger coaches of General Motors manufacture. Walker, formerly manager of manufacturers' sales for the Dominion Rubber Co., will make his headquarters in Oshawa.

SAE members who were speakers at the February meeting of the Lubrication Committee, Division of Marketing, the American Petroleum Institute: **W. E. BETTONEY**, assistant manager of the technical section, Petroleum Chemicals Division, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., "Preignition in the Modern Automobile"; **VINCENT AYRES**, assistant chief engineer, Valve Division, Eaton Mfg. Co., Battle Creek, Mich., "Valves and Valve Gear—the Gimmicks that Make a Successful Tank Train;" **M. M. ROENSCH**, director of laboratory tests, Research Laboratories Division, GMC, Detroit, "Automotive Power—Gas Turbines or Piston Engines?"

C. W. GEORGI, technical director, research laboratories, Quaker State Oil Refining Corp., Buffalo, was chairman of the Program Committee, and **H. G. STRINGER**, lubrication engineer of Shell Oil Co., Detroit, was chairman of the Detroit Committee on Arrangements. The meeting was held in the Sheraton-Cadillac Hotel, Detroit.

ERNEST G. STOUT has received The Sylvanus Albert Reed Award for 1953 from the American honorary fellows and fellows of the Institute of the Aeronautical Sciences. Stout is staff engineer in charge of hydrodynamic research and development at Consolidated Vultee Aircraft Corp.'s San Diego Division.

The Sylvanus Albert Reed Award is presented annually for a notable contribution to the aeronautical sciences resulting from experimental or theoretical investigations which have had a beneficial influence on the development of practical aeronautics. Stout was cited for "his analytical and experimental contributions to the design and development of high-speed water-based aircraft."

ELFRIED F. H. PENNEKAMP, formerly a section head in the Research Division of the Standard Oil Development Co., Linden, N. J., is now on the staff of the company's new Enjay Laboratories Division. He will have the responsibility for the sales technical service activities in the field of the company's additives. He will still be located at the Esso Research Center in Linden.

HOWARD W. HINES, formerly a junior engineer at the Cessna Aircraft Co., Wichita, Kansas, is now draftsman for the Caterpillar Tractor Co. in Peoria, Ill.

CHARLES E. HEITMAN has been promoted to assistant general manager of the A. O. Smith Corp. Heitman was previously general manager of the Milwaukee Works of A. O. Smith.

HILBERT S. RADER is now an experimental engineer for the Allison Division of GMC, Indianapolis. He was a senior project engineer at the Cadillac Division of GMC, Cleveland tank plant.

HERBERT ROY JAFFE is now an industrial designer for the American Safety Razor Corp., Brooklyn, N. Y. Previously, he was senior automobile style designer with GMC's styling section.

C. H. CHATFIELD has been elected to the 1954 board of directors of the Manufacturers Aircraft Association, Inc., New York. Chatfield is secretary of United Aircraft Corp., East Hartford, Conn.

HARRY VIKTORSSON is director of research at the Motor Engine Manufacturers' Research Institute, Trondheim, Norway. He was a consultant and sales engineer for the Swedish Quaker State Agency, Astrom Bros. Co., Inc., Stockholm, Sweden.

New IAS President

J. L. ATWOOD, president, of North American Aviation, Inc., has been elected president of the Institute of the Aeronautical Sciences for 1954. He succeeds **CHARLES J. McCARTHY**, vice-president of the United Aircraft Corp., Hartford, Conn., who has held the IAS office for the past year. Atwood was sponsor of SAE's Aircraft Production Forums held in connection with the National Aero Meetings in October '51 and October '52.


Atwood

Other SAE members were elected vice-presidents: **W. A. M. BURDEN**, partner of William A. M. Burden & Co., New York; **E. T. PRICE**, president and general manager of Solar Aircraft Co., San Diego; **E. S. THOMPSON**, sales manager of General Electric Co.'s Aircraft Gas Turbine Division at Cincinnati. **ELMER A. SPERRY, JR.**, vice-president of Sperry Products, Inc., Danbury, Conn., is treasurer and **ROBERT R. DEXTER** is secretary.

SAE members who have been elected fellows of the Institute of the Aeronautical Sciences are: **MYRON G. BEARD**, chief engineer, American Airlines, Inc.; **PERRY W. PRATT**, chief engineer, Pratt & Whitney Aircraft Division, United Aircraft Corp.; **E. C. WELLS**, vice-president, engineering, Boeing Airplane Co.

IAS fellowships are bestowed upon those persons who have made notable and valuable contributions in one of the aeronautical sciences or in aeronautical engineering.

Receives Air Force Medal

JAMES H. KINDELBERGER, chairman of the board of North American Aviation, Inc., is shown receiving the Air Force Exceptional Service Medal from Harold E. Talbott, Secretary of the Air Force. The citation reads, in part: "James Howard Kindelberger distinguished himself by rendering exceptional service to the United States Air Force and his country for 40 years as an engineer, designer and producer of military aircraft."

He is also the recipient of Italy's highest civilian award, the order "Al Merito Della Repubblica Italiana." The award was given to him, "for his outstanding the Italian authorities in the difficult task of developing a common program of aircraft production in Italy."
achievements in the aeronautical field and for the friendly cooperation given to

SAE Fathers and Sons . . .

B. FRANK JONES (left) and **BEN F. JONES** were among SAE members at the National Meeting last January. The elder Jones is chief engineer of the Autocar Division, White Motor Co., Ardmore, Pa. His son is chief engineer of the Wheel & Brake Division, B. F. Goodrich Co., Troy, Ohio. This picture was taken outside the press room of the Sheraton-Cadillac Hotel as the Joneses studied a meeting program.

Also at the meeting were **DONALD B. BROOKS** (right), executive director, Committee on Fuels & Lubricants, Office of the Secretary of Defense, and his son, **DONALD K. BROOKS.** Brooks, Sr. has been an SAE member for 30 years.

The younger Brooks is a research technician for Ford Motor Co., Dearborn, Mich.

If any SAE reader knows of SAE Father-and-Son combinations, both of whom are members of the Society, your editors would appreciate hearing from you. We will write for photographs. Informal pictures are preferred to individual formal portraits. Your cooperation will be deeply appreciated—we don't want to miss any SAE grouping.

Obituaries

JOSEPH R. JAGGER

Joseph R. Jagger, president of Joe Jagger Sales Co., Toronto, Ontario, Canada, died in an automobile accident last November 18. He was 47.

Before he organized his own company, Jagger was sales manager and technical advisor for the R. M. Hollingshead Co. of Canada, Ltd. in Toronto. His work at Hollingshead included calling on fleet accounts, construction companies and airplane manufacturers to give data on the application of lubricants, solvents, and rust preventatives.

Prior to his work with Hollingshead, he was employed in the sales department of the Firestone Tire & Rubber Co., California.

Besides SAE, Jagger held membership in the Toronto Rotary Club.

CHARLES F. HERRESHOFF

Charles Frederick Herreshoff, 77, retired automotive engineer and naval architect, died January 31 at his home in San Diego.

Herreshoff was the designer of an automobile that won the American Automobile Association's gold medal in 1910. He was also the designer of the Alabama and the Vim, two championship motor yachts. The Alabama was winner of the American motor-yacht championship in 1907, '08 and '09. The Vim won the New York-Poughkeepsie motor yacht races in '08 and '09. The Iroquois won the Canada Cup, and the Vivian the Hudson-Fulton Celebration races.

CHARLES OWEN BURGESS

Charles Owen Burgess, technical director of the Gray Iron Founders' Society, died at his home in Cleveland, January 13. He would have been 52, January 21.

Prior to joining the staff of the Gray Iron Founders' Society in 1948, he was head of the industrial service department of the Research Division of Union Carbide & Carbon Corp. He held more than a dozen patents in the steel and gray iron field and was also well known for his technical articles on the metallurgy of iron and steel. He was nearing completion of a gray iron handbook for users of castings.

Burgess was born at Little Falls, New York, and was a graduate of Lehigh University, from which he obtained the degree of Metallurgical Engineer.

He was a member of many organizations besides the SAE. They include the American Foundrymen's Society, American Society of Testing Materials, American Society of Mechanical Engineers, American Society of Metals, American Institute of Mining and Metallurgical Engineers, National Academy of Science, American Ordnance Association, and the American Society for Quality Control. He served on many committees in these and in other technical organizations.

He is survived by his wife, two sons and a daughter, his father and brother.

J. H. BALLARD

J. H. Ballard, retired chief technical engineer at Sealed Power Corp., Muskegon, Mich., died at his home in Long Beach, California, December 28. He was 67.

Ballard became associated with the Sealed Power Corp. in 1929 and served in various capacities until his retirement in 1951. He was well known throughout the industry as one of the leading piston ring engineers. He held many patents and contributed greatly to piston ring advancement and design, particularly during World War II.

Surviving are his wife and two daughters.

ALFRED E. GRATER

Alfred E. Grater, at one time sales engineer for the Clark Equipment Co., Berrien Springs, Mich., died January 11. He would have celebrated his sixty-sixth birthday January 21.

Grater had a variety of engineering experience with different companies. At Clark he was responsible for contacting the customers' engineers about new design developments, as well as about any design changes desired or required on production units. The rest of his time was devoted to production and development design in the Transmission Division's engineering department.

Previously, Grater was assistant chief engineer of Reo Motor Car Co., Lansing, Mich., where he supervised all truck and coach design. He had been coach-transmission engineer on GMC's trucks; assistant chief engineer of the Muncie Products Division, GMC; in charge of the gear lab, Chevrolet Motors, Toledo; and designer and experimental engineer for the Warner Gear Co., Muncie, Ind.

Though born in Germany, Grater was a citizen of the U. S. He attended grade school at Plymouth, Ind., and studied mechanical drawing from International Correspondence School lessons. He also took extension courses in fabrication and treatment of steel from Purdue University.

NOEL WARNER BOULEY

Noel Warner Bouley, assistant chief engineer of the San Diego Division of Consolidated Vultee Aircraft Corp., died January 24 after a brief illness. He was 47.

Before joining Convair in 1936, Bouley was in the engineering department of Boeing Aircraft Corp., Seattle. In 1943 he was appointed project engineer of Convair's New Orleans Division, and became chief division engineer the following year. He was later transferred to the company's San Diego Division as design group engineer. He then became project engineer, chief project engineer, and in 1951 assistant chief engineer.

Bouley was born in Aberdeen, South Dakota, attended grade schools in Jefferson, Oregon, and high school in Everett and Olympia, Washington. In 1933 he graduated with a B.S. degree from the University of Washington, Seattle.

Besides the SAE, he was a member of the Institute of the Aeronautical Sciences, Optimists International, Boy Scouts of America, Phi Gamma Delta, Tau Beta Pi, Sigma Xi, and the University Christian Church.

HAROLD CLUTTERBUCK

Harold Clutterbuck, technical officer to the Society of Motor Manufacturers and Traders, London, England, died October 19. He was 63.

Clutterbuck had been with the SMMT since 1922 where he was continuously in contact with the engineers of the Industry. He was secretary to many technical meetings which cover a wide range of technical items, including discussions on steels, fuels and lubricants.

Previously he was a machine tool designer for H. W. Ward & Co., Ltd., Birmingham. He had entered industry at the age of 16 as a machine tool draughtsman for James Archdale & Co., Ltd., Birmingham.

Personals

continued from page 101

GEORGE M. HOLLEY, JR., president of the Holley Carburetor Co., Detroit, and **RUSSELL S. STRICKLAND**, executive vice-president of Bower Roller Bearing Co., Detroit, have been elected directors of the Manufacturers National Bank of Detroit.

LLOYD M. CREGOR, JR. is now branch manager of The White Motor Co., San Antonio. He was in the sales department of The White Motor Co. in Houston.

KENNETH G. MACKENZIE, vice-president of The Texas Development Co., New York, is secretary of the U. S. National Committee for the Fourth World Petroleum Congress to take place in Rome, Italy, June, 1955. The purpose of the Congress is to give those people engaged in the oil business in different parts of the world an opportunity to exchange views regarding technical problems of the petroleum industry and to see different approaches used in solving such problems. Other SAE members who are participating are: **H. G. VESPER**, California Research Corp., San Francisco; **R. C. ALDEN**, Phillips Petroleum Co., Bartlesville, Okla., and **W. M. HOLADAY**, Socony-Vacuum Oil Co., New York.

R. F. CHRISTOPHER has been appointed to active direction of the newly-formed Sales Promotion-Export Division, Sun Electric Corp., Chicago. Christopher has been long active in the firm's contacts with automotive manufacturers. He has now fully recuperated from a serious illness, which forced his retirement from the position of director of sales promotion and advertising about two years ago.

GEORGE A. DELANEY has been elected board member of the Award Committee for the Standards Medal, given by the American Standards Association. He is chief engineer, Pontiac Motor Division, GMC.

Delaney

Nyberg

CHRIS NYBERG has announced that after a brief vacation he will be available as a consultant on farm machinery at 4 Pioneer Avenue, Battle Creek, Mich. This rounds out a lifetime of work for Nyberg in engineering the manufacture of harvesting machinery for the Oliver Corp., the Allis-Chalmers Mfg. Co., and the Advance-Rumely Co. Nyberg retired recently as chief engineer of Oliver Corp.'s Plant One in Battle Creek. He is currently serving on SAE's Tractor and Farm Machinery Activity.

DR. MAURICE J. DAY was one of a three-man team of experts from the Armour Research Foundation of the Illinois Institute of Technology that recently completely a two-week study of Hawaii's present and potential industries. Dr. Day is assistant director for program development at the Foundation.

A. W. CHANDLER has announced the change of name of the Refinery Mfg. Co. to Chandler Engineering Co. Chandler is president of the company.

PAUL L. CAIRNS has been named manager of design and construction, The Mansfield Tire & Rubber Co., Mansfield, Ohio. Cairns has been group head of design and construction.

JAMES B. LIGHTBURN has been appointed general sales manager, After Market Sales Division, Purolator Products, Inc., Rahway, N. J. He will supervise all of Purolator's after market sales dealing with major oil companies, wholesalers, and jobbers. Previously he has acted as assistant to the vice-president in charge of sales.

Lightburn

Clouser

WALTER A. CLOUSER has been elected vice-president in charge of sales of Muskegon Piston Ring Co., Muskegon, Mich. Clouser was manager, Detroit sales office, for the company.

DONALD C. HAYS has joined the Lockheed Aircraft Corp., in Marietta, Ga., as a liaison engineer. Hays was formerly a senior project engineer at the Buick-Oldsmobile-Pontiac Assembly Division of GMC.

GENE P. ROBERS has been appointed sales manager of the newly-created Distributor Division of The Weatherhead Co., Cleveland. The new division comprises the former Automotive Standard Parts Division and that portion of the old Industrial Division handling distributor accounts in all 48 states. Robers was previously sales manager of the Standard Parts Division.

Robers

Ellis

R. G. ELLIS of the engineering department, Micromatic Hone Corp., Detroit, has been promoted to assistant chief engineer. Ellis has been designing machine tools for 27 years.

MICHAEL PINTO, president of Douglas Tool and Pioneer Engineering & Mfg. companies, has been elected president of the Michigan chapter of the Young Presidents' Organization.

Students Enter Industry

JOHN WILLIAM DICKERSON (General Motors Institute '53) is a junior design engineer in the Detroit Diesel Engine Division of GMC.

LE GRAND DERBY FEELEY, JR. (Purdue University '53) is an engineer in the flight research department of Sikorsky Aircraft at Bridgeport, Conn.

NEVILLE MITCHELL (University of British Columbia '53) is a junior engineer with Industrial Engineering, Ltd., Vancouver, B. C.

JOHN SKUBIAK (Fenn College '53) is a junior engineer in the electrical laboratory of the Steel & Tube Division of Republic Steel Co., Canton, Ohio.

ROBERT C. WYKES (Bradley University '53) is an aerodynamicist at North American Aviation, Inc., at Columbus, Ohio.

JAMES L. JONES is assistant training director of Acme Steel Co. in Chicago.

ALLEN ROBERT SHAAK (Academy of Aeronautics '53) is a final assembly mechanic at Piasecki Helicopter Corp., Morton, Pa.

JAMES F. COVINGTON (University of Washington '51) is a methods engineer in industrial engineering at the Pacific Car & Foundry Co., Renton, Washington.

PENMETCHA SOMARAJU (Madras Institute of Technology '53) is a trainee in the Central Tractor Organization, Government of India, at Bairagarh, Bhopal State, India.

A. N. CAVE (Purdue University '53) is a service Engineer at Ensign Carburetor Co., Chicago.

KENNETH LEROY WHEELER (Detroit Institute of Technology '53) is with the Burroughs Corp., Plymouth, Mich., as an electrical design engineer.

BANSUN CHANG (University of Wisconsin '53) is a research associate at the University of Wisconsin.

JOHN I. MANECKE (Lawrence Institute of Technology '53) has joined the Detroit Controls Corp. Manecke is a research engineer.

RICHARD A. HARSTRICK (Academy of Aeronautics '53) is now with the Colonial Airlines at LaGuardia Airport, Flushing, N. Y. He is a mechanics' helper.

TAKEO SHIBATA (University of Illinois '53) is a junior mechanical engineer, in the mechanical section, division of architecture, State of California.

FRIEDRICH G. HECKERT (General Motors Institute '53) is now with Adam Opel A. G. (General Motors' subsidiary) at Russelsheim-Main, Germany.

DONALD O. PEARSON (Utah State University '53) is a mechanic at Birch-Lytle-Green Construction Co., Baker, Idaho.

GEORGE CONDRASHOFF (Stanford University '53) is a technical apprentice with Pacific Gas & Electric Co., San Francisco.

COE Shortcomings Need Prompt Attention

Based on paper by

F. R. NAIL
Mack Manufacturing Co.

AMONG the shortcomings of the COE tractor which have come to light with broader use and which truckers insist must be remedied are:

1. Relatively harder riding than the conventional type.
2. Higher cost of sheet metal maintenance.
3. Comparative inaccessibility of powerplant.
4. Driver discomfort due to fumes, engine heat, and noise.
5. Complication and inconvenience of controls.

Hard riding of the type peculiar to COE tractors seems to be the most fundamental shortcoming in respect to its causes, and to call for the most basic engineering approach in its solution.

Preferred methods for the alleviation of hard riding characteristics appear to be:

1. Modification of combination designs to permit longer wheelbases within same overall combination lengths.
2. Control spring flexibilities to position center of oscillation at or behind rear axle.
3. Cushioning of fifth wheel impacts.

(Paper "Methods of Overcoming Inherent Disadvantages of COE" was presented at SAE National Transportation Meeting, Chicago, Nov. 4, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members; 60¢ to nonmembers.)

Employee Training Keeps Turnover Down

Based on paper by

VAL CRONSTEDT
A. V. Roe, Canada

FACED with the need to expand its manufacturing personnel for the production of gas turbine engines, and lacking a supply of suitably trained people to draw upon, A. V. Roe hired graduates from many schools and

trained them. There are three major parts to this program, as follows:

1. Familiarization course.
2. Instruction on cutter grinding methods.
3. Administrative and supervisory development program.

By means of the familiarization course, new employees are given an overall appreciation of the work of the gas turbine division as a whole. At the same time, older employees are given a chance to see how the rest of the manufacturing shop operates and where parts belong in the finished product, to offset any detrimental effect on morale due to the monotony of repetitive work.

Instruction on cutter grinding methods is a brief manufacturing course covering cutting tools, mathematics and theory. This course was essential because of the scarcity of qualified applicants for all operations.

The administrative and supervisory development program has four parts:

1. An introduction into human behavior.
2. Industrial relations case history discussions.
3. Lectures on industrial practices, and company organization and administration.
4. Indoctrination in the principle and operation of the product.

Thanks to the training course, employee turnover compares favorably with that of the top five U. S. aircraft companies. From January to October 1953, the real operating period, the monthly turnover rate was 2½%. (Paper "The Creation of an Aviation Engine Industry in Canada" was presented at SAE International Production Meeting, Toronto, Oct. 30, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Will We Go To European Styling?

Based on paper by

GEORGE ROMNEY

Nash-Kelvinator Corp

FOUR factors will decide whether Americans will trade the family car for European styling.

1. Americans are bigger than ever.
2. They are travelling more.
3. Multiple-car ownership is on the increase, hence the second or third car may differ in size and type from the family car.
4. Increase in cost of operation will

give rise to a demand for an American-type small car.

The American car of the future, therefore, will embody the modern functionalism of post-war Italian design, without sacrifice of existing spacious comfort and convenience. (Paper "Will Americans Trade the Family Car for European Styling?" was presented at SAE Detroit Section, Dec. 7, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

CRC Reports '51-'52 Car Antiknock Requirements

Based on paper by

H. W. Best
Yale University

Leonard Raymond
Socony Vacuum Oil Co., Inc.

R. K. Williams
Research Laboratories Division, GMC

Complete paper will appear in 1954 SAE Transactions.

FOR comparison with previous surveys, the CRC in 1951 conducted a statistical survey of the fuel antiknock requirements of 450 postwar passenger cars. This survey also included an investigation of new design engines and transmissions, and the effects of age and use on requirements of selected models. This latter investigation was continued in a 303-car survey in 1952.

Results of this comprehensive program indicate that:

- Octane-number requirements of postwar passenger cars did not change between 1949 and 1951.
- As in the 1949 survey, the 1951 and 1952 surveys showed no significant differences in requirement among cars used in the Eastern, Central, and West-Coast areas of the United States.
- Maximum octane-number requirements, measured in terms of Research octane numbers of commercial and severity reference fuels, for cars as a whole are within two octane numbers of the requirements measured in terms of primary reference fuels. The differences in maximum requirements for individual car makes may be considerably greater, however.
- Statistical survey data in 1949 and 1951 showed that maximum knock occurred most frequently in the speed range from 750 to 1400 rpm. The percentage of cars showing

maximum requirements above 1400 rpm increased from 22% in the 1949 survey to 29% in the 1951 survey.

- Tank-fuel data for the 1949, 1951, and 1952 surveys are not directly comparable due to differences in car selection. It has been observed, however, that the percentage of cars knocking on regular grade fuel is consistently greater than the percentage knocking on premium fuel. The percentage of cars found knocking by observers have been similar to those reported by their owners.
- Limited data indicate that even after the initial 3000 miles of operation, maximum octane-number requirement continued to increase for several thousand miles.
- A comparison of the individual makes tested in the 1952 survey showed that from 0 to 70% had maximum requirements at part throttle. Maximum octane-number requirement was reported at part throttle in 11% of the cars tested in the 1951 statistical survey.
- Maximum requirements for one 1952 make in which a manual-shift transmission was used were approximately four octane numbers higher than for identical models using a torque-converter transmission.

(Paper "Antiknock Requirements of Passenger Cars—1951-1952" was presented at SAE National Fuels and Lubricants Meeting, Chicago, Nov. 6, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers. Full paper will be published in 1954 SAE Transactions.)

Maintenance Needs Direct Supervision

Based on paper by

J. C. O'BRIEN

MacMillan Bloedel, Ltd.

MAINTENANCE of off-highway automotive equipment used by the logging industry of British Columbia has a long way to go before even approaching the peak of efficiency. No single factor is more important in maintenance, or in any operation, than the direct supervision of the employees who are actually doing the work.

Supervisors should be made to feel they are front-line management. This can be done by top management taking an active interest in the maintenance department and recognizing the abilities, judgment, and role the super-

visors play in company operations. Management people are generally situated far from operations and seldom, if ever, come in contact with the immediate supervision of maintenance. In the majority of cases, the only things that concern them are the cost sheets. As a result, some equipment has been retired too early, while some is so antiquated that one wonders why figures haven't shown it up. (Paper "Problems in Off-Highway Automotive Machinery Maintenance as Applied to Logging in British Columbia" was presented at SAE International West Coast Meeting, Vancouver, B. C., Aug. 17, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members; 60¢ to nonmembers.)

Shift From Design To Production Eased

Based on paper by

R. B. McINTYRE

The de Havilland Aircraft of Canada, Ltd.

IN our experience, the key to a smooth transition between design and production is the experimental department.

The department's main function is to produce prototype aircraft. It also deals with normal mock-ups, functional mock-ups, test pieces, structural tests, and all special requirements and development work. This department should be as self-contained as possible, should be located close to the design department, and be directly responsible to the chief engineer.

Our experimental department is also responsible for prototype servicing and flying, actual flying, of course, being in charge of the chief test pilot, and flight programs under the control of the aerodynamic section of the engineering department.

The experimental department is a kind of common meeting ground for design and production engineers. During prototype stage, we have found it profitable to station a group of production engineers right in the experimental shop, to advise on all new details from a production angle. The following things can be done through this group:

1. Suggestions can be made directly to designers before experimental drawings are prepared, with a view to a certain method of manufacture making use of existing production equipment.

2. The production group is able to draw up schedules of material, par-

ticularly castings, forgings, and extrusions, which have long delivery times, thus giving the production department an early lead.

3. The production team is able to guide the experimental shop as to the best way of making prototype parts.

4. The production engineer can observe the way in which various details assemble. Potential production difficulties can be discussed with designers and drawing changes put in train.

5. The production engineer can arrange for some details to be fabricated in the production shops on a short batch basis. This lifts the load on the experimental shop and begins to make the production department aware of, and interested in, the new project. This is most likely to happen with those parts requiring special equipment such as presses, hammers, furnaces and the like.

In all this there is the ever present risk of modification. By smooth cooperation between design and production these risks can be reasonably well assessed so that production can be started earliest on the minimum risk items.

The successful completion of structural tests and functional mock-up tests are of great importance to the production man. As each unit passes test, the risk of modification drops considerably thus clearing many details for production. (Paper "Production Engineering for the Civil Market" was presented at SAE International Production Meeting, Toronto, Oct. 30, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

State Laws Bring COE Tractor to Fore

Based on paper by

LEWIS C. KIBBEE

American Trucking Associations, Inc.

AN operator may want the COE tractor to obtain more payload space because his freight is light and he needs space to approach the loading allowable. On the other hand, another operator may require this type of vehicle because his lading is very heavy, even though he is well within the length limits. He wants to get more of the payload on the front axle to insure proper distribution of gross load in relation to the axles.

The conventional tractor appears satisfactory in the field where it has

as much as 8 to 10 ft to be fitted to the semitrailer. When this space is smaller, as with the sleeper cab, or in states where the length of the single vehicle is unrestricted, the COE would seem necessary due to lack of space in which to fit the conventional unit. If the difference between semitrailer length and length of the overall combination is sufficient to warrant building a body on the tractor, but 8 to 10 ft is insufficient to make a body interesting, the COE comes into the picture again. It seems axiomatic that the COE should be as short as possible to do the best job. (Paper "The Need for Dimensional and Operating Characteristics of the COE Chassis" was presented at SAE National Transportation Meeting, Nov. 4, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

More Accessibility Is COE Epuipment Need

Based on paper by

L. E. KASSEBAUM

Consolidated Freightways, Inc.

ANY attack on the cost of maintaining COE units must take into consideration the number of miles between service operations and the hours or minutes required for each operation.

For instance, if a fuel or oil filter, requiring inspection every 2500 miles or 50 times a year, were to be relocated so that it required one-half hour longer to service, just to save three hours in the removal of heads, and the latter operation would be required only twice a year, such a relocation would be impractical.

To increase accessibility and reduce service some thought might be given to driving fans, generators, and air compressors on a separate accessory shaft, possibly from the power take-off. To achieve longer life, it would seem reasonable to pursue the development of magnetic drives for these same accessories. It would reduce the number of service operations.

In our opinion the maintenance of COE units is no more costly than that of conventional equipment, but there is greater room for improvement in design. (Paper "Fleet Maintenance Characteristics of COE Tractors and Trucks" was presented at SAE National Transportation Meeting, Chicago, Nov. 4, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

New Members Qualified

These applicants qualified for admission to the Society between Jan. 10, 1954 and Feb. 10, 1954. Grades of membership are: (M) Member; (A) Associate; (J) Junior; (SM) Service Member; (FM) Foreign Member.

Atlanta Group

James A. DeSana (J).

Baltimore Section

Calvin H. Cropper (A), Earl C. Hoffer (J).

Buffalo Section

William G. Cowdin (J), Donald I. Hall (J), Robert W. Kennedy (J), Ernest R. McAdoo (A), Arthur Edmund Miller (M), Carl O. Peterson (M), Emil J. Vodonick (M).

Canadian Section

Joseph M. Brian (M), Thomas Bullough (J), Douglas Kirkaldy (M), Roderick J. McGregor (M), Edmund B. Niescior (J), John B. Rea (J), Ellis Ezra Sion (A), John D. C. Waller (J).

Central Illinois Section

Donald Peter Diemer (J), Joseph G. Fedor (J), John H. Hyler (M), Lt. Gerald Allen Jensen (J), Donald J. Tomasek (J).

Chicago Section

George Richard Armstrong (M), James Richard Bateman (M), Charles Robert Bell (M), Roger Kenneth Ericson (M), Paul D. Gilson (M), William S. Hammel (A), James Lester Knearem (J), Frank Ludicky (J), William Walter Merryman (A), Robert O. Neff (J), Ralph A. Nelson (A), Matthew F. O'Brien (M), Robert J. Outland (J), Thomas Arthur Racine (J), Fred T. Schick (J), Ralph A. Schlarb (A), Domenic P. Tortorici (J).

Cleveland Section

Sal Frank Artino (J), William H. Carter (J), Alexander Boyt Clarke (M), William M. Day (M), Leonard E. Foglesong (J), Howard W. Goodknight, Jr. (A), Dale C. Greig (J), Earl Hobein (M), M. J. Hoke (M), Manfred Holder (J), David King (J), James L. Laws (J), Robert R. Markgraf (J), James R. McConnell (A), Peter Van De Carr (J), William G. Wallace (M), George Martin Weisenberger (A).

Dayton Section

Richard L. Carmon (J), James O. Helvern (M).

Detroit Section

Ray M. Adsit (M), James F. Albrecht (J), Herbert H. Alvord (M), William A. Armstrong (J), Ward James Atkinson (J), Charles R. Barnes (A), Raymond C. Collins (J), Robert Craver (J), Roger G. Crete (M), Benjamin G. Davis (M), Omer C. DeClercq (A), George Venner Derisley (J), John Eric Desmond (M), Norbert J. Ernat (M), C. Fred Feindt (J), Nolan Joseph Fugazzi (J), Thomas J. Galbreath (J), Donald H. Gill (A), John C. Gilmer (A), Hubert T. Graether (M), William Henry Graumlich (J), Walter J. Hagen (M), Howard D. Hall, Jr. (J), William P. Hazel (A), Cecil J. Heiden (M), Howard James Hildenbrand (A), Walter Hintzen (M), Jack F. Hockman (J), Conrad J. Hohmann (M), R. Brian Honeyball (M), Douglas Hughson (M), William D. Innes (M), Dale Robert Johnson (J), Kalin S. Johnson (J), Melville G. Kennedy (A), Walter A. Kosztowny (J), Allen M. Krass (J), Leonard LaBuda (J), Clarence B. Lawrence (J), William Martin (J), Arthur F. Martz, Jr. (M), Edward B. Mazzotta (M), Hugh J. McNichol, Jr. (J), Robert Leo Nagel (J), Richard J. Nuffer (M), Earl N. Pearson (A), Raoul J. Pepin (A), David Walter Peterson (M), Michael Rasich (M), G. Raymond Reed (M), Fred M. Rose (J), Charles Robert Rutherford (J), George R. Ryder, Jr. (J), Edward Saarinen (M), James F. Sabiston (A), Richard W. Sinko (J), Richard Herbert Smith (J), Tracy W. Smith (M), A. Gil Spear, Jr. (M), William R. Spence (J), James Stewart (M), Robert C. Taylor (J), Don Herbert Wacker (J), Robert Morton Wagner (M), Fred J. Warrell (J), Joseph T. Wentworth (J), Harry T. Williams (M), George Wisniewski (A), Robert V. Yazejian (A).

Hawaii Section

James H. Davis (M), Gabriel K. M. Lau (A), Nicholas Serra (A).

Indiana Section

John S. Craig (M), Corwin T. Geyer (M), James V. Harrison (J), Kearney K. Kozai (J), C. A. Lindblom, Jr. (J), John B. Mastin (M), James W. McKinney (M), John H. Murphy (A), Donald Wallace (J).

Kansas City Section

R. L. Davis (M), Major James W. Kelly (A), Harold John Snyder, Jr. (J).

Metropolitan Section

Peter J. Caruso (M), George Clarke (J), Harold David Connelly (A), Wallace J. Franklin (M), Robert E. Helmus (A), James England Hulsizer (M),

Continued on Page 114

New Members Qualified

continued

George H. Lowden (A), Theodore McGill (M), Dominick Militello (J), Percy E. Mizelle (J), C. W. Nichols, Jr. (M), C. J. Nuttall (M), Leo Peters (A), Achille Giovanni Vannucci (M), George E. Wilson (A).

Mid-Continent Section

Charlie F. Loftin, Jr. (J).

Mid-Michigan Section

Richard R. Bey (J), Thomas R. Leonard (J), E. G. Lill (M), Robert A. Mooney, Jr. (J), Earl W. Pierce (M), Arthur J. Scaife (M), Bruce W. Smith (J).

Milwaukee Section

Lionel H. Ames (J), Eric H. Dodge (J), John H. Fellows (J), Floyd W. Johnson (M), Alan R. Kishline (M), Donald Eugene Peterson (J), Rufus K. Schriber, Jr. (A).

Mohawk-Hudson Group

Glenn Raymond Stevens, Jr. (J), George E. Veen, Jr. (J).

Montreal Section

J. L. Andre Bachand (A), John Bain Stirling (J).

New England Section

Charles A. Caliri (A), Edward A. Downs (J), Edward E. Eldridge (M), John George Rueppel (J).

Northern California Section

Jules M. Barsotti (A), James E. Conner (M), Curtis L. Fent (M), Frederick Warren Ranke (A), Hollis R. Williams (M), Richard C. Wilson (J).

Northwest Section

Rodger E. Holmstrom (A), Lloyd J. Thurston (J).

Philadelphia Section

John W. Brooks (M), Daniel J. Grady (J), Louis Huis, Jr. (J), Theodore W. Nelson (M), Byrd F. Parmelee (J); Gene F. Pierson (J), Oliver A. Sprague (J).

Pittsburgh Section

Roderick S. Spindt (M).

St. Louis Section

Earl R. Lane (J), Charles O. Traylor (J), James Dennison Truesdale (J).

Salt Lake Group

Ross W. Eskelson (M).

San Diego Section

Carl Louis Frasher (J), A. Woodrow

New Members Qualified

continued

Grindle (M), Angelo A. Mattei (M), Merril M. Reeder (A).

Southern California Section

Harry Ewing Cornish (M), Harry Eugene Cotrill, Jr. (J), Stanley Groner (J), Carl William Hay (A), Harry N. Hill (J), Elmer D. King (J), Charles George Knapp (J), V. H. Knowles (A), Bavard H. Lalande, Jr. (J), Richard D. Livingston, Jr. (J), Leon Louis Lyons (J), Manabi Matoba (A), Raymon M. Miller (J), Robert J. Petersen (M), David Alexander Philipp (J), Charles R. Richards (J), Anthony Scotch (J), Henry DeWain Spiekerman (M), Eugene Thomas Sullivan (J), A. Armond Tolomeo (A).

Southern New England Section

Robert Lovejoy Beattie (J), Donald L. Brown, Jr. (M), Harold W. Dean (A), Calvin D. Holbert (J), Donald Charles Marr (J), John W. Morse (M), Richard W. Rupert (J).

Texas Section

Robert C. Breckur (J), Charles J. Kam (A), George Edward Lange (M), Lt. Willard G. Palm (A), Paul E. Petty (J), Edward J. Roseler (M), Bob C. Wright (M).

Texas Gulf Coast Section

Andrew E. Kennedy (A).

Twin City Section

Richard K. Barton (A), William C. Canby (A), M. J. McCarty (M), Robert L. McMillan (M), Frank S. Morgan (M), David J. Wisehart (M), Rahland C. Zinn (M).

Washington Section

Benson E. Gammon (M), William Robert Harwood, Jr. (J), Milton M. Slawsky (M), Donald M. Thompson (M), Rover Lawrence Tilley (M).

Western Michigan Section

Albert J. Christopher (J), William C. Martin (M).

Wichita Section

John H. Creighton (A).

Outside Section Territory

Marshall C. Armstrong (M), Harvey D. Carbiener (M), W. J. Derksen (M), Shih-Chien Kao (J), John Joseph Martin (J), B. H. McMillan (M), Kenneth Oliver Robinson (M), G. J. Shaw (M).

Foreign

Julius Liebel (M), Germany; Hashim M. Sanduk (J), Iraq; Richard Stent (M), New Zealand; Jyotindra Manharlal Vakil (J), India.

Applications Received

The applications for membership received between Jan. 10, 1954 and Feb. 10, 1954 are listed below.

Baltimore Section

Robert Frick Cecce, John E. Traise.

Buffalo Section

Howard J. Heindell.

Canadian Section

Edward Adams, Samuel F. Bacher, William F. Beattie, Michael Franklin Bederaux-Cayne, Robert M. Campbell, John Mervin Cochrane, Frank Edward Doran, Ernest W. Bartle, Ernest Arthur Clifton, J. Gordon Couper, John C. McMurdie, Geoffrey Haddon Roost, A. Leigh Taylor.

Central Illinois Section

Ernest C. Davis, Ronald E. Dennis, Duane Elwyn Evans, Dean D. King, William Franklin Lindeman, Richard Glenn Warner.

Cincinnati Section

Bruno W. Bruckmann, J. D. Graham.

Chicago Section

Charles E. Allderdice, Jr., Robert L. Bester, George Boswinkle, Don E. Elliott, Leonard C. Ganderton, Raymond F. Gramberg, Joseph Lencki, Sidney G. Olling, Phillip E. Owen, Joseph Vincent Pizzillo, Richard K. Reese, Charles H. Skuza, Raymond H. Snyder, Mrs. Willow E. Wilcox, Fielding W. Wohrer.

Cleveland Section

Duane A. Burgeson, Alan Arnold David, Myron R. Day, Richard H. Gardner, John J. Goodill, Carroll P. Krupp, Edward O. Meisner, Thomas A. Robertson, Carl Stefancin, John E. M. Taylor, John Brooks Theurer, John A. Walko.

Dayton Section

Frank M. Barnhill, John Robert Caldwell, William E. Few, John B. McKee.

Detroit Section

Charles S. Ashbrook, Jr., T. J. Ault, Andrew Beresik, Fred Birkendahl, Howard E. Blood, Jr., Edgar W. Caldwell, William K. Campbell, Harry L. Clark, Arthur A. Conrad, Jr., Edward James Paul Cunningham, James R. David, Tad John Derengowski, Donald C. Dickinson, Raymond S. Embree, Edward Fischer, Glen R. Fitzgerald, James Frank Forster, Albert E. Goodwin, Gordon W. Jacobson, James Clinton Jones, Wade Carl Karash, James Stuart Kawsky, John R. Kellner, Charles A. Kelly, Theodore R. Kermou, Alger G. Koepfgen, Robert V. Kumpula, Lyndell Irving Lewis, Fred A. MacArthur, Robert D. Marcy, Richard J. McHugh, Adam Mike Miller, Arthur Miller, John Modell, Jr., Herbert K. Morales, Frederick Wendell Phillips, John M. Roop, Galdino Salvador, Francis A. Sciabica, Thomas Scott, Robert E. Sechrest, Karl M. Sims, W. Maynard Smith, Sam Sniderman, George R. Squibb, Glen E. Spade, Jr., Noel Edward Stasel, Richard A. Teague, John W. Tenhundfeld, Paul Albert Tracht, Donald Philip Walker, Ting-Ming Wang, Joel A. Warren, John Edward Webster, William Winn, Jr., Stephen A. Zdan.

Hawaii Section

Harry K. Sproull.

Applications Received

continued

Indiana Section

Harold Keith Johnson, Robert David Morrison.

Kansas City Section

R. H. Beymer, Isaac Herbert Hoover, Charles J. Middleton, Arnold R. Peterson.

Metropolitan Section

Andrew R. Barr, Alexander Bloch, Harry V. Chioffe, Thomas Harrison Dooley, Thomas C. Fetterman, Theodore Richard Gondert, John Medwin, H. E. Moerman, Clayton S. Myers, Joseph A. Orsino, Everett C. Post, Ted Powell, Robert Simmons Richardson, Horace M. Skinner, Howard S. Stevens.

Mid-Continent Section

Charles J. Smith.

Mid-Michigan Section

Joseph B. Depman, James R. Lane, Jr., Robert P. Rohde, David P. Smith, Gerhard W. Sood, Thomas K. Tamashiro, Harvey Bertrum Wilgus.

Milwaukee Section

Elmer Alfred Eigenberger, Edgar J. Justus, John C. McAlvay, Howard J. Pike.

Mohawk-Hudson Group

Robert T. Doty.

Montreal Section

Donald F. Currie, Gerald L. Lackman, Lt.-Col. Anthony Miller.

Northern California Section

Jack V. Harris, Bert G. Johnston, Vaughn R. Smith.

New England Section

William Williard Hart, William S. Lewis, Dixon Benjamin Sawin.

Northwest Section

Stanley U. Cutler, Jr., R. M. Peterson.

Oregon Section

S. L. Jackson.

Philadelphia Section

John A. Jackson, Jr., H. Warren Jacobs, William Ibsen, Jr.

St. Louis Section

James B. Davis.

Salt Lake Group

Glen R. Bradford.

Continued on Page 119

Applications Received

continued

San Diego Section

I. Dagan, Robert D. Henschel, Rodney Allan Hidde, E. S. Oppenheimer, Floyd Frank Rechlin, Fred H. Rohr, Jr., Robert Alvin Wedgewood.

Southern California Section

George R. Aldrich, John F. Beach, Arthur Laudy Burton, Herman L. Coplen, Jr., Sam Hanks, Irving F. Littman, Alexander B. Magnus, Jr., Dan McCann, Charles W. Pickens, Thomas J. Rollins, Richard W. Sellwood, McKinley W. Thompson, Jr., Burl S. Watson, Jr.

Southern New England Section

Frank C. Codola, Frederick R. Schollhammer, Benjamin Arron Schranze, Robert Hedges White, Thorton Grant Woodwell.

Syracuse Section

Carl A. Benscoter.

Texas Section

R. C. Howren, William W. Hurtt, Marvin G. Starr.

Twin City Section

Robert Donald Atkins, Ernest E. Jacobs, Latier O. Nelson.

Texas Gulf Coast Section

Hiram P. Talley.

Virginia Section

Frank T. Richards, Jr.

Washington Section

Edson L. Barlow, Jr., William Howard Dunham, Charles Pierpont Hoffmann, Jr., Donald H. Tsai.

Wichita Section

A. S. Odevseff.

Williamsport Group

J. D. Irons, George E. Mallinckrodt.

Outside of Section Territory

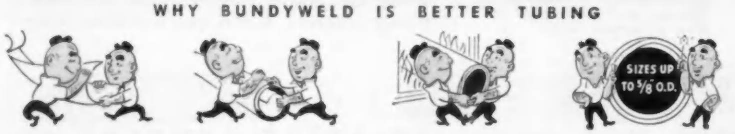
Frederick H. Beelby, Alfred Dennis Cole, John J. Dorwin, Adolf von Euw, Lewis M. Hough, James H. Kress, W. Curtis Miller, Frank Wilson Quiggin, Harvey William Ritchie, William G. Slater, Carl Spangenberg, Kenneth E. Tibbits, William J. Vachout, Thomas A. White, Ralph Langdon Young.

Foreign

Jorge Acosta, Colombia, S.A.; Necati Anameric, Turkey; Hans Heinrich, Germany; Nils Ake Jonson, Sweden; Itsuo Kagehira, Japan; Shiv Nath Koshal, India; Colin John Prebble, England; Bronock Albert Reid, Trinidad.

Let Bundyweld help you profit from the automotive air conditioning boom!

WHY BUNDYWELD IS BETTER TUBING



Bundyweld starts as a single strip of copper-coated steel. Then it's . . .

continuously rolled twice around laterally into a tube of uniform thickness, and

passed through a furnace. Copper coating fuses with steel. Result . . .

Bundyweld, double-walled and brazed through 360° of wall contact.

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Automotive air-conditioning sales climb daily. Experts see the sale of 500,000 air-conditioned cars a year just around the corner. The boom is under way.

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For instance, did you know that Bundyweld's ability to tame escape-minded refrigerants has made it the standard of the refrigeration industry for over twenty years? Did you know that the refrigeration industry uses about 1,000,000 feet of Bundyweld daily for its compressors, condensers, evaporators, connector lines, and other refrigeration tubing parts?

Of course, we back up the world's most dependable small-diameter tubing with unexcelled fabrication facilities and a staff of expert engineering specialists—plus custom packaging of your orders; prompt, on-schedule deliveries and the bulldog-like tenacity of working with you until any tubing problem is cracked. Call, write, or wire for information or for help with your air-conditioning problem.

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DETROIT 14, MICHIGAN

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Bundyweld nickel and Monel tubing are sold by distributors of nickel and nickel alloys in principal cities.

This Thompson "Engineered Steering" development is a good example of Thompson cooperation with the automotive industry for more than 50 years.

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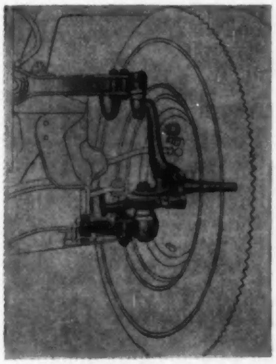
were Lincolns, equipped with Thompson Front Suspension Ball Joints



IN fact, 7 Lincolns were in the list of the 10 prize winners in the recent annual Mexican Pan-American stock car race and all were equipped with Thompson Front Suspension Ball Joints.

This severest automotive test in the world . . . 1,912 miles over every type of roadway . . . has proved beyond the shadow of a doubt that Thompson's famous Front Suspension Ball Joints provide the easiest handling and steering control in automotive history.

In addition, Thompson's ball joints reduce lubrication points from 12 to 4 . . . eliminate front end suspension bind . . . create new space for wider modern engine design . . . and increase service life *many times over.*

Thompson's front suspension ball joints, used successfully on Lincolns for the past two years, are now found on the latest Mercury and Ford models.

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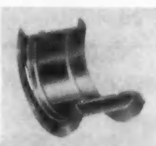
CASE

HERCULES



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DETROIT 11, MICHIGAN

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Probably the best way to learn the reasons for this outstanding record of acceptance would be to ask the scores of individual truck operators and manufacturers who make it possible. Some of these individuals would undoubtedly cite their long association of over 25 years' experience with Bendix-Westinghouse Air Brake Equipment. Others might dwell on the prompt aid and assistance provided by Bendix-Westinghouse sales and service representatives. Many would mention the money-saving Bendix-Westinghouse factory reconditioning program and nation-wide distributor organization. But regardless of whatever else might be mentioned, it's a safe bet you'd find one basic reason shared by all—Bendix-Westinghouse Air Brakes deliver more miles of satisfactory performance at lower cost than any other air brake on the market! Why not keep it in mind next time you specify brakes?
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AIR BRAKES
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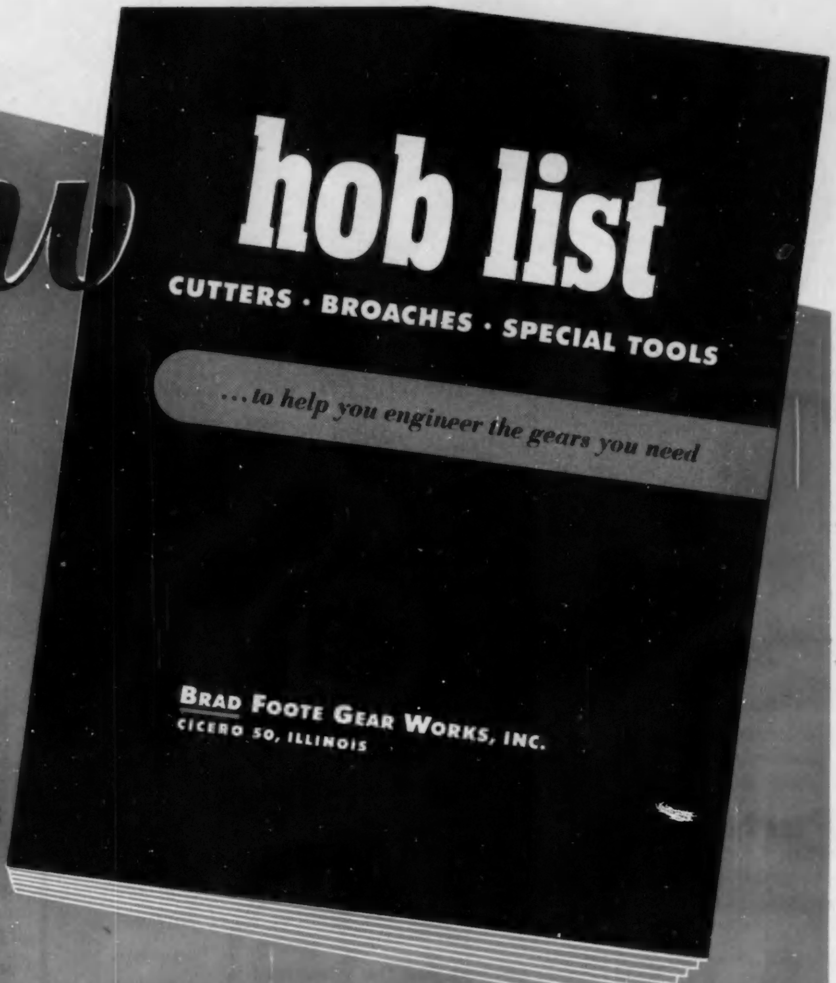

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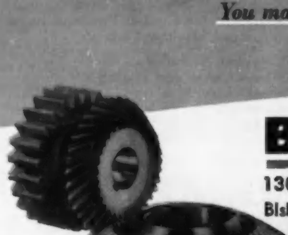

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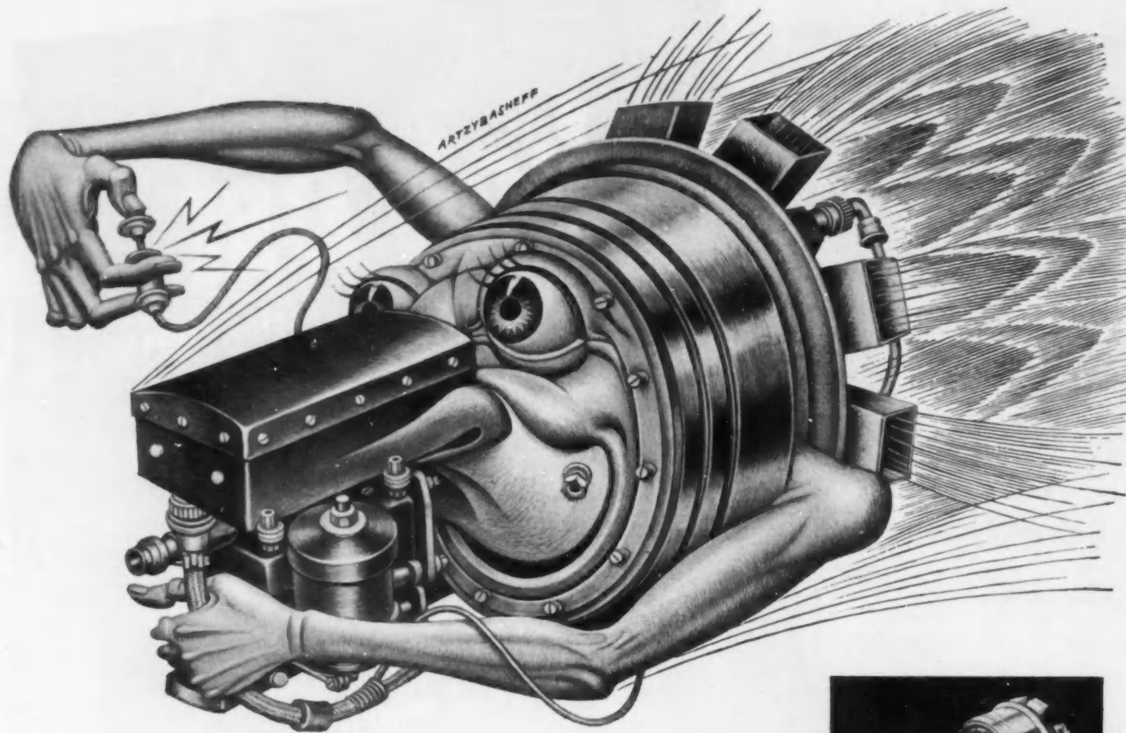

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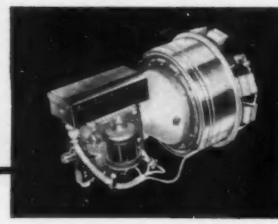

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Manufacturing plants in Stratford, Conn., and Williamsport, Pa

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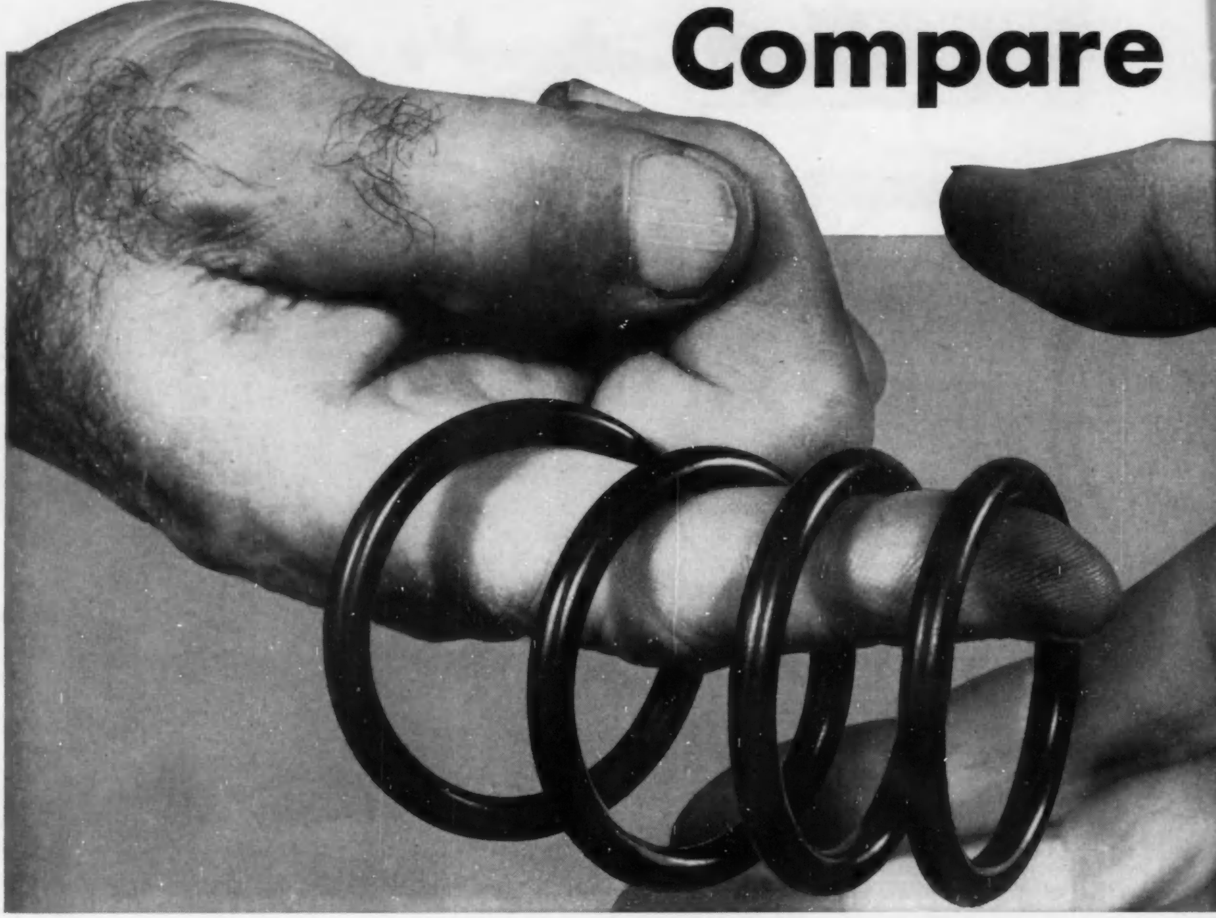

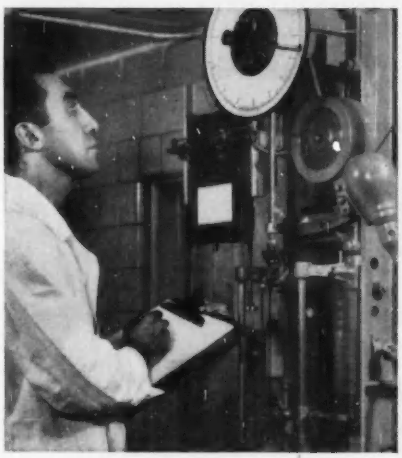

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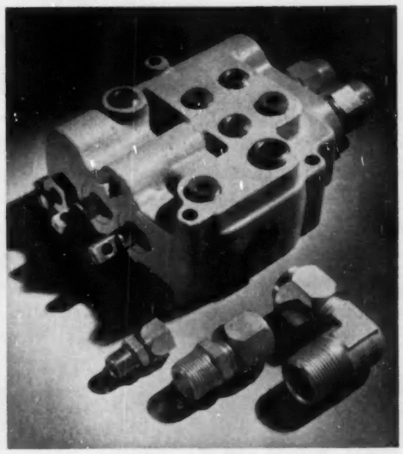
1. For trouble-free, leakproof sealing, you can depend on Parker O-rings. They are precision molded of superior compounds that have been developed as the result of thousands of tests. When you ask about Parker O-rings, we check your specifications to determine which of our O-rings is exactly *right* for your *specific* application. Then, we invite you to make your own comparison tests of Parker O-rings with any other make. Here are some of the reasons why you'll find that Parker O-rings seal better and last longer:

5. Get complete data in Catalog No. 5100. Ask your Parker representative or mail the coupon for a copy. Then, compare actual sample O-rings.



6. What other Parker products for *hydraulic* and *fluid* systems interest you? Triple-lok flare fittings? *Ferulok* flareless fittings? New directional control valves? Any others?

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Section 504-M
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Cleveland 12, Ohio

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- ☐ Custom-molded rubber catalog No. 5201A1
- ☐ Information about these other specific Parker products________

NAME____________ TITLE________

COMPANY____________

ADDRESS____________

CITY____________ STATE________

RUBBER PRODUCTS DIVISION
The Parker Appliance Company
17325 Euclid Ave., Cleveland 12, Ohio
1538 South Eastern Ave., Los Angeles, Cal.

Parker

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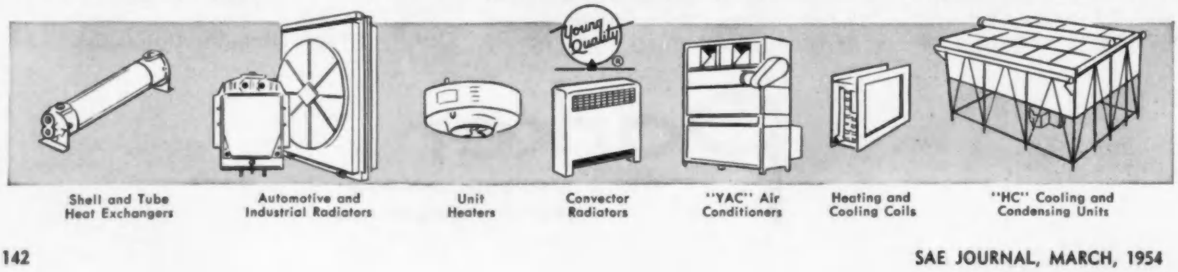


Shell and Tube Heat Exchangers | Automotive and Industrial Radiators | Unit Heaters | Convector Radiators | "YAC" Air Conditioners | Heating and Cooling Coils | "HC" Cooling and Condensing Units

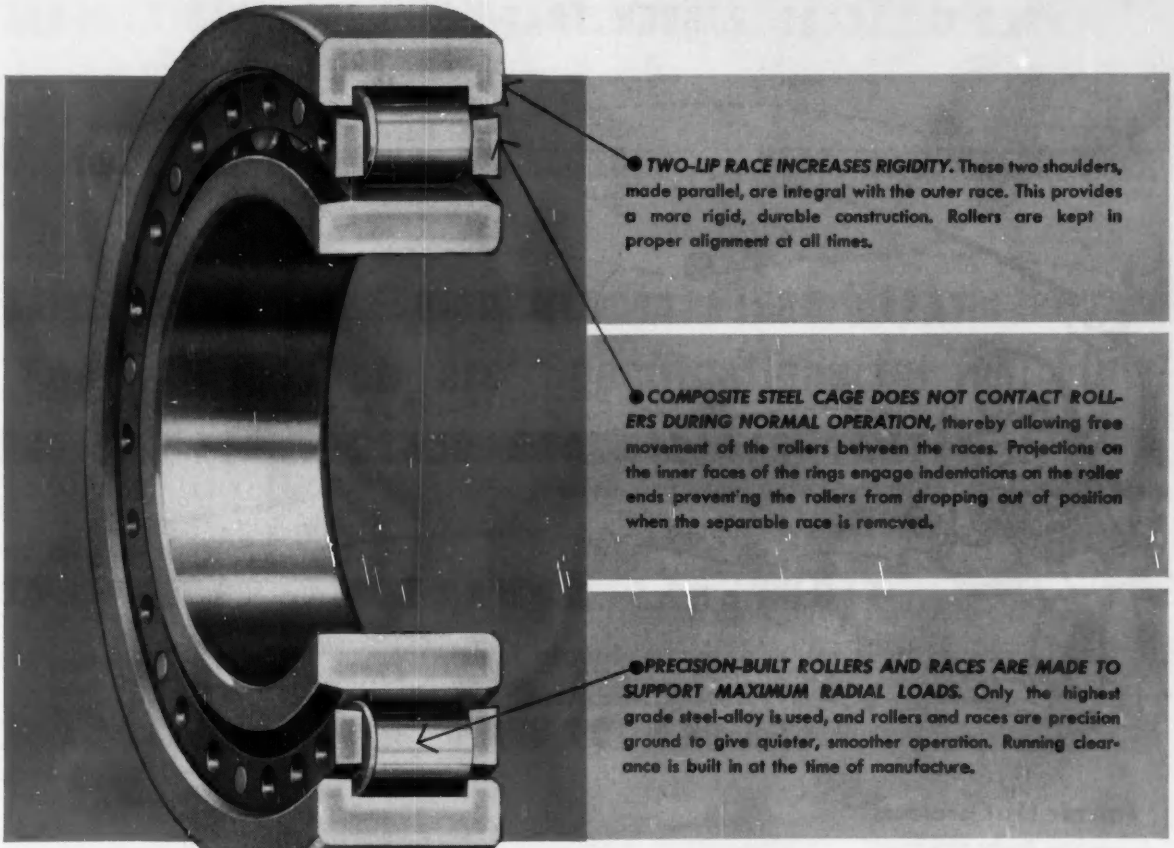
Here's why BOWER straight roller bearings can carry maximum loads—with less maintenance!

The important design features of Bower straight roller bearings shown on this page are just a few of the reasons why these bearings will operate efficiently and economically in your product. Consider these facts, too. Bower straight roller bearings incorporate highest quality materials and workmanship. They have proved themselves capable of standing up day in and day out under maximum loads—with little or no maintenance.

In fact, this is the reason why Bower straight roller bearings are used extensively by leading manufacturers in such fields as automotive, earthmoving, farm equipment and machine tool.

Let a Bower engineer give you full details of the complete Bower line. Call him in while your product is still in the blueprint stage.

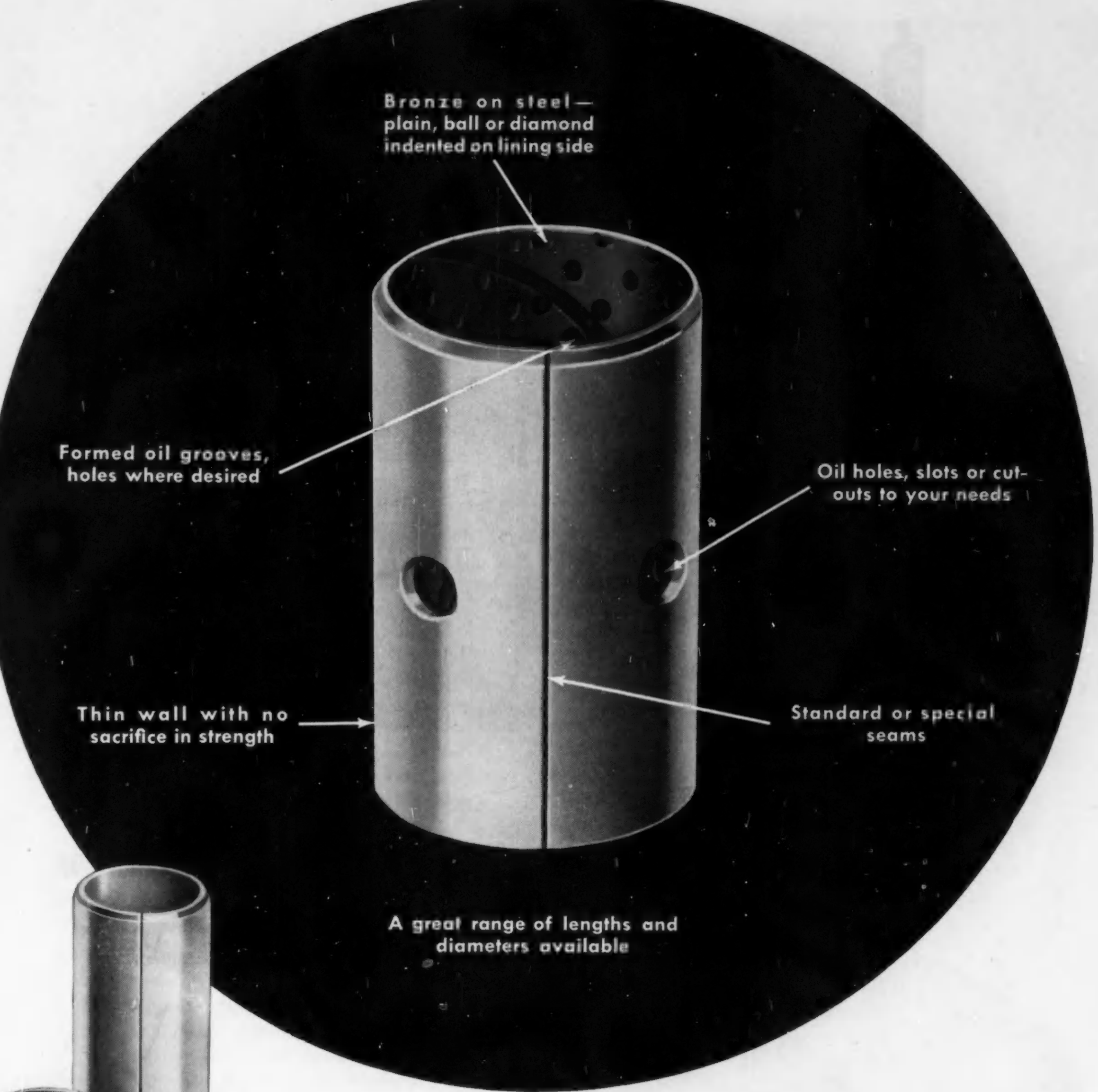
BOWER ROLLER BEARING COMPANY • DETROIT 14, MICHIGAN

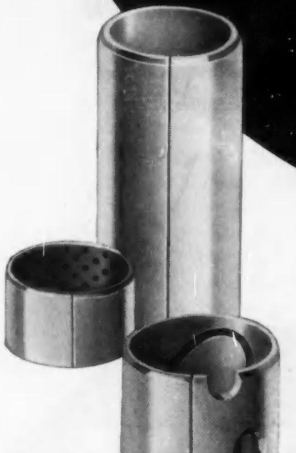


A COMPLETE LINE OF TAPERED, STRAIGHT AND JOURNAL ROLLER BEARINGS FOR EVERY FIELD OF TRANSPORTATION AND INDUSTRY

BOWER ROLLER BEARINGS

SPHER-O-HONED





Also available in tin-base or lead-base babbitt on steel.

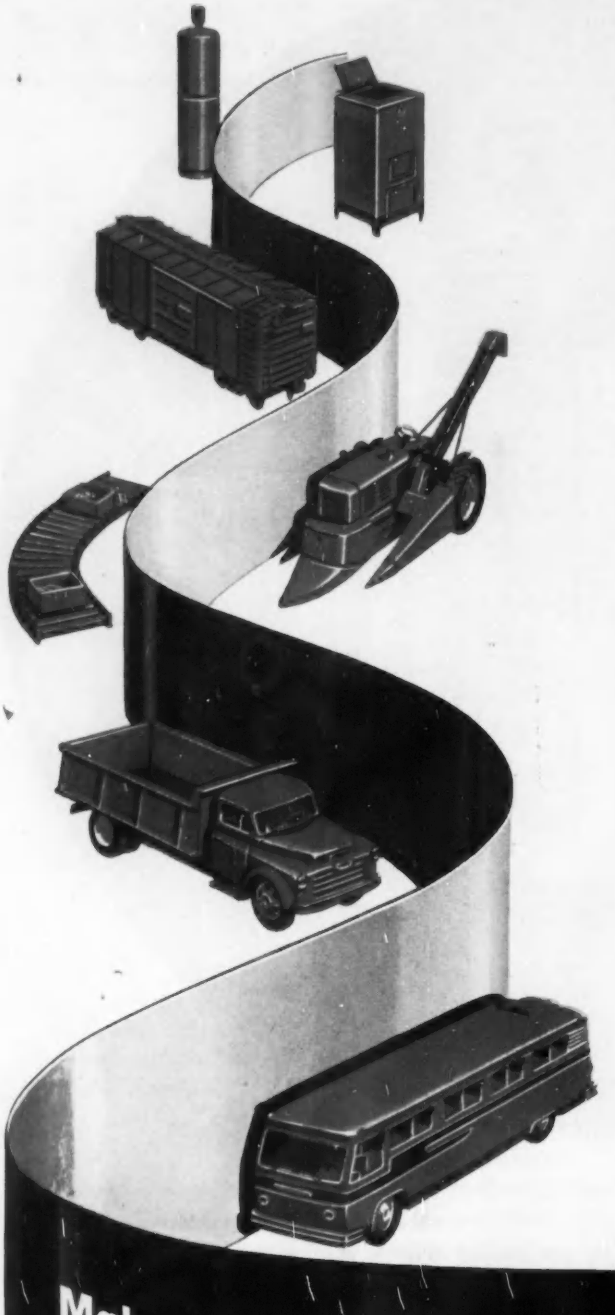
Get bearing performance at bushing cost. Save material, time and labor with Federal-Mogul bimetal rolled split bushings. Quality production in large volume runs for hundreds of uses can mean savings in *your* application.

FEDERAL-MOGUL CORPORATION, 11035 Shoemaker, DETROIT 13, MICHIGAN

FEDERAL Mogul since 1899

FEDERAL-MOGUL

Sleeve bearings in all designs and sizes; cast bronze bushings; bimetal rolled bushings; rolled split bushings; washers, spacer tubes, precision bronze parts and bronze bars.



You can design light weight, longer life, and economy into your products by including N-A-X HIGH-TENSILE in your plans.

It is 50% stronger than mild steel.
It is considerably more resistant to corrosion.
It has greater paint adhesion with less under-coat corrosion.
It has high fatigue life with great toughness.
It has greater resistance to abrasion or wear.
It is readily and easily welded by any process.
It polishes to a high lustre at minimum cost.

And with all these physical advantages over mild carbon steel—it can be cold formed as readily into the most difficult shaped stamping.

Sound like something for you? Ask for full facts and think of N-A-X HIGH-TENSILE when you re-design.

GREAT LAKES STEEL CORPORATION

N-A-X Alloy Division — Ecorse, Detroit 29, Michigan

NATIONAL STEEL CORPORATION

Make it WEIGH LESS... and LAST LONGER with

N·A·X

HIGH-TENSILE STEEL

Charles A. Dana

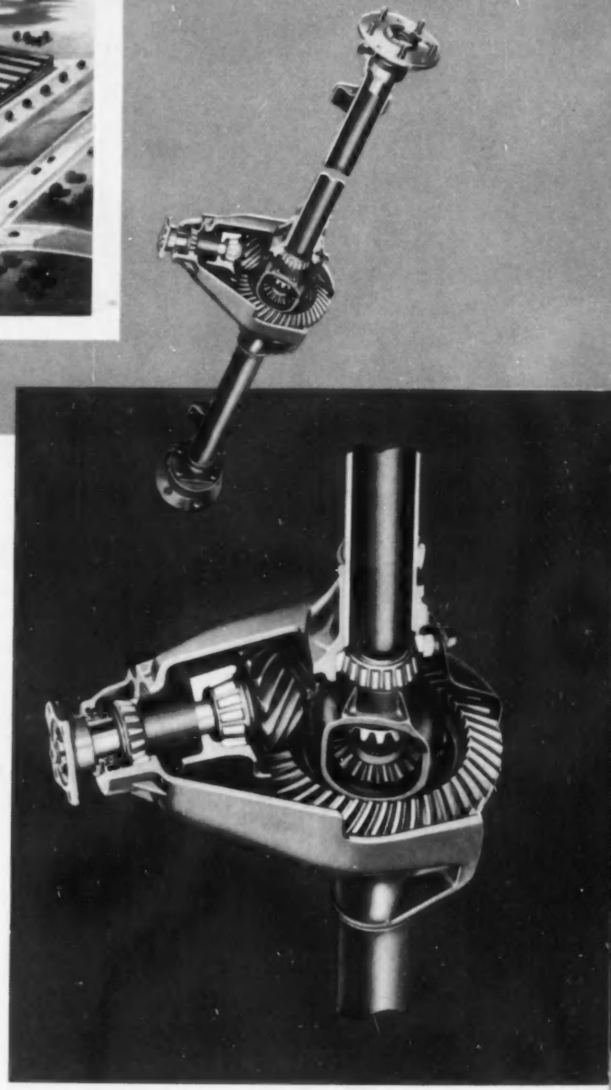
What do you know about Dana?

The Dana Corporation comprises a group of industries that is widely diversified in lines of manufacture. Its principal service is to those companies producing passenger cars, trucks, buses and tractors, and other self-propelled vehicles, for civilian and military use. Many Dana products are used in the aircraft industry, and as components in a wide range of machinery and appliances.

The Dana Corporation had its founding in the Spicer Corporation in 1904. This company was formed by Clarence W. Spicer, inventor of the first commercially-produced automotive universal joint. Spicer Joints now are used as standard equipment on a majority of the world's automotive vehicles. Today the Dana Corporation produces in its 10 modern domestic plants, and associated plants in Canada, Great Britain and France, the following products: transmissions, universal joints, propeller shafts, Brown-Lipe and Auburn clutches, forgings, axles, stampings, Spicer Brown-Lipe gear boxes, Parish frames, torque converters, power take-offs, power take-off joints, rail car drives, railway generator drives, aircraft gears, and welded tubing.

THIS IS SPICER IN FORT WAYNE, INDIANA

The Salisbury Axle Division of Dana Corporation is devoted exclusively to the manufacture of the Spicer Salisbury Axle, widely used in automobiles, taxicabs, and light trucks



For nearly 50 years, "SPICER SALISBURY" has meant *quiet axles*

The Spicer Salisbury Axle for passenger car and light commercial use is engineered for long, quiet life. It offers these special features:

RIGIDITY—The special Spicer design and construction maintain accurate alignment of gears and bearings under all speeds and loads. Result: *quiet axles!*

LUBRICATION—Scientifically developed control of oil circulation provides a constant, correctly proportioned flow to all gears and bearings for effective lubrication and cooling. Result: *quiet axles!*

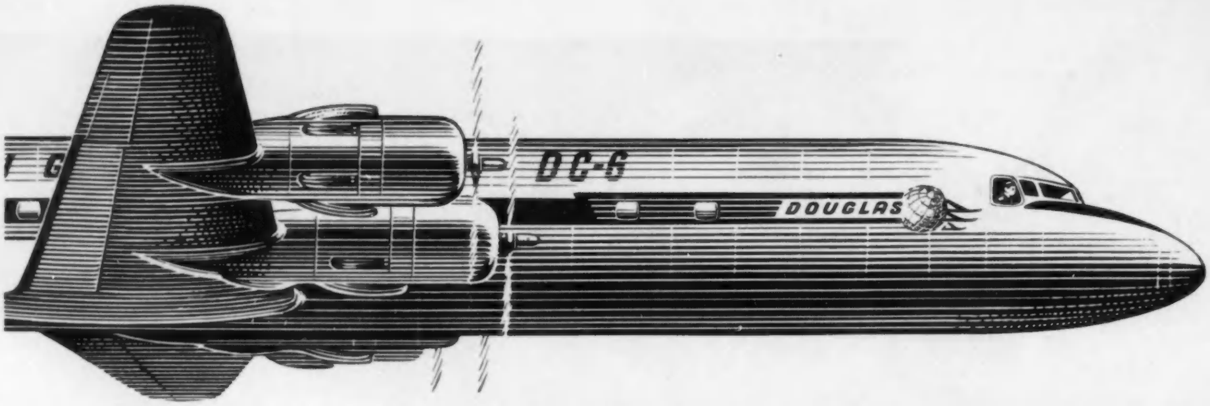
RUGGEDNESS—Sturdily constructed to withstand the high speeds and extremes of punishment which are common in modern automotive vehicle operation. Result: *quiet axles!*

SPICER MANUFACTURING DIVISION
of Dana Corporation • Toledo 1, Ohio

50 YEARS OF
Spicer
SERVICE

TRANSMISSIONS • UNIVERSAL JOINTS • PROPELLER SHAFTS • BROWN-LIPE and AUBURN CLUTCHES • FORGINGS • AXLES • STAMPINGS • SPICER BROWN-LIPE GEAR BOXES • PARISH FRAMES • TORQUE CONVERTERS • POWER TAKE-OFFS • POWER TAKE-OFF JOINTS • RAIL CAR DRIVES • RAILWAY GENERATOR DRIVES • AIRCRAFT GEARS • WELDED TUBING

ENGINEERING
DANA
MANUFACTURING



IN TERMS OF PROFIT...
PERFORMANCE...COMFORT

THE GREATEST

Latest model of the famed Douglas DC-6, the DC-6B represents the ultimate in this series of great, four-engine air transports. It was the DC-6B which flew 5700 miles from Los Angeles to Paris last May in 20 hours to complete the longest non-stop flight ever made by a commercial airliner. The superior performance of this airplane under all conditions and its acceptance by the flying public have established it as an outstanding profit-maker.

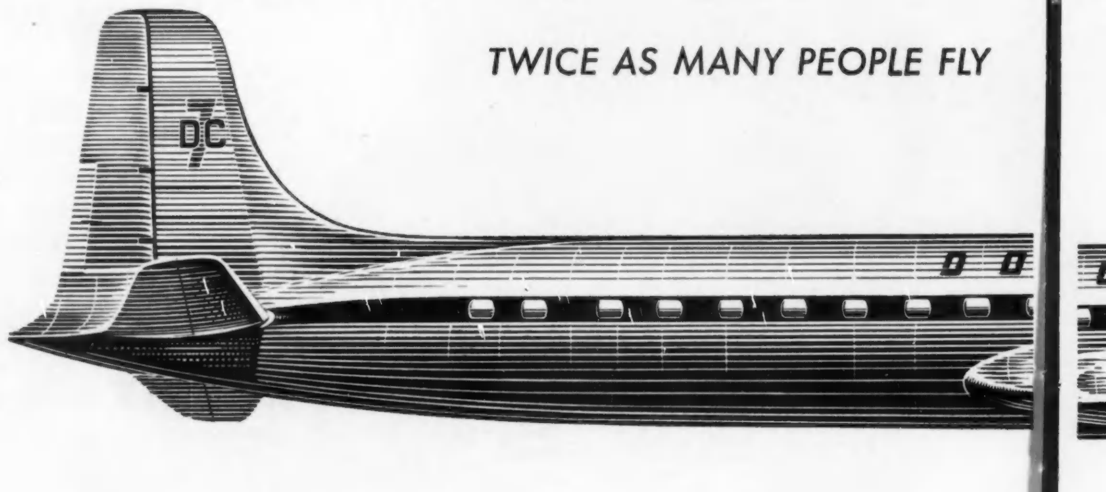
DC-6
SERIES

"Queen of the Fleet" on these leading airlines of the world is the famous Douglas DC-6 or DC-6B

AA *Argentine* • *AIGLE AZUR *French* • ALITALIA *Italian* • AMERICAN *U. S.* • ANA *Australian* • BCPA *Australian New Zealand* • BRANIFF *U. S.*
CMA *Mexican* • *CGTA-AA *French* • CONTINENTAL *U. S.* • CPAL *Canadian* • DELTA-C&S *U. S.* • *EASTERN *U. S.* • FLYING TIGER *U. S.*
JAL *Japanese* • KLM *Netherlands* • LAI *Italian* • *LAN *Chilean* • NATIONAL *U. S.* • *NORTH AMERICAN *U. S.* • NORTHWEST *U. S.* • PAL *Philippine*
PANAGRA *U. S.* • PAN AMERICAN *U. S.* • SABENA *Belgian* • SAS *Danish Norwegian Swedish* • SLICK *U. S.* • SWISSAIR *Swiss*
TAI *French* • UAT *French* • UNITED *U. S.* • WESTERN *U. S.*

*Soon

TWICE AS MANY PEOPLE FLY



RALPH KRESS, Exec. V.P. & G.M. of Dart Truck Co., has created a heavy-duty truck of new design, powering it with a Waukesha Super Duty Six

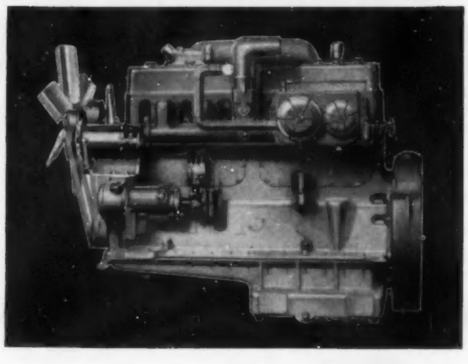
new design FOR HEAVY DUTY

POWERED BY

WAUKESHA

Utilizing the full power of its Waukesha 6-WAKR Butane Engine for driving—the newly designed 30-ton Dart 35-SA End-Dump Truck is most unusual. All auxiliaries, including the cooling system, are driven by a smaller engine, a Waukesha 195-GKU. Mounting the engines amidships (centered between the wheels), and the wagon-type front axle, both exclusively Dart, give many advantages. Waukesha power means pay-load performance plus economy.

☆ Powering this Dart 30-tonner is this Waukesha 6-WAKR Butane Super Duty Six: 6¼" x 6½", 1197 cu. in. displ., 290 hp at 1800 rpm



Super-Duty Six 1197 CU. IN. 6-WAK *Series*

- **6-WAK—Gasoline Engine**
- ☆ **6-WAKR—Butane Engine**
- **6-WAKDB—Diesel Engine**
- **6-WAKDBS—Supercharged Diesel Engine**

UP TO 352 MAXIMUM HORSEPOWER

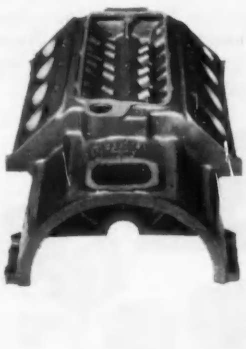
Standard or Counterbalanced Crankshafts available. Consult Waukesha on permissible speeds for your service.

SEND FOR BULLETINS

WAUKESHA MOTOR COMPANY • WAUKESHA, WISCONSIN

NEW YORK TULSA LOS ANGELES 237

They're pouring horsepower into **smaller** packages



Stallions of industry, harnessed to pull a mighty load . . . that's horsepower in a V-type engine. With this unique design, more power is concentrated in less space . . . put to work with greater efficiency. Almost 40 years ago Campbell, Wyant and Cannon poured its first V-shaped cylinder block – helped give heart to this now famous power plant. Since then advances have been many, with CWC sparking the way – *building more V-type cylinder blocks than any other independent contract foundry.* Teaming its long experience with a constant search for the new and better, CWC gives V-type engine builders cylinder blocks that possess finest physical properties . . . that lengthen engine life, step-up engine performance. Next time you think of castings . . . think of CWC. Learn what a difference the *right* casting can mean to your product.

CWC

Since 1908

CAMPBELL, WYANT AND CANNON
FOUNDRY COMPANY
Muskegon, Michigan

"it is significant..."

THE Four Wheel Dri[...] AUTO
MFRS. OF FWD TRUCKS
CLINTONVILLE, WIS

OFFICE OF THE PRESIDENT

January 19, 1954

Blood Brothers Machine Division
Rockwell Spring & Axle Company
Allegan, Michigan

Gentlemen:

In November, 1953, The Four Wheel Drive Auto Company introduced a new line of four and six wheel drive trucks to mark the Company's 43rd year in the heavy duty truck field.

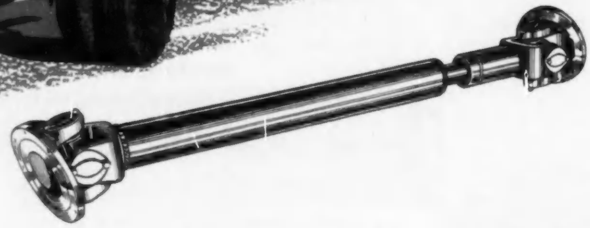
I think it is significant that Blood Brothers has supplied us with propeller shafts and alignment joints every one of those 43 years. From the first FWD Model B trucks built in 1910, to the latest 1954 models now on our production line, Blood Brothers drive lines have been used and are now being used as standard equipment.

To me that is an honest measure of our faith in your product. In our experience, Blood Brothers has always meant a fine product backed by excellent service and cooperation. I am sure that the same [...] can lead to many more years of business [...]een your Company and FWD.

Yours very truly,

Robert A. Olen

Robert A. Olen
President and General Manager



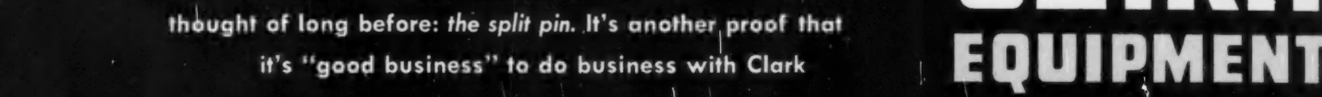
UNIVERSAL JOINTS
AND DRIVE LINE ASSEMBLIES

BLOOD BROTHERS machine division
Rockwell Spring and Axle Company
ALLEGAN, MICHIGAN

This One Works

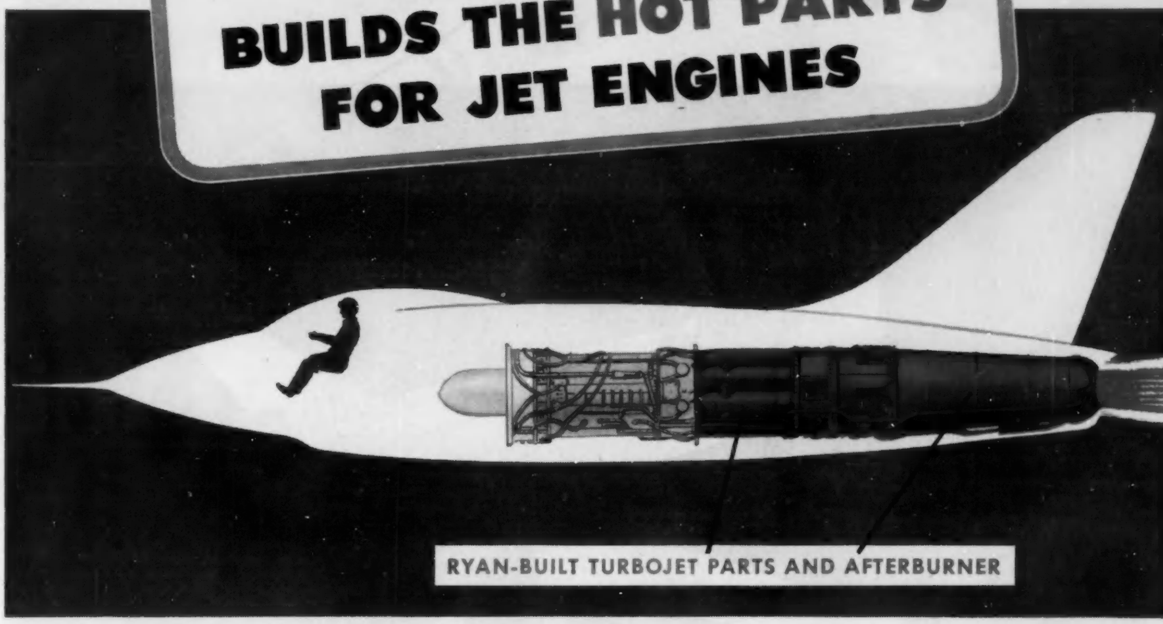
An idea so simple you wonder that it wasn't thought of long before: *the split pin*. It's another proof that it's "good business" to do business with Clark

CLARK EQUIPMENT

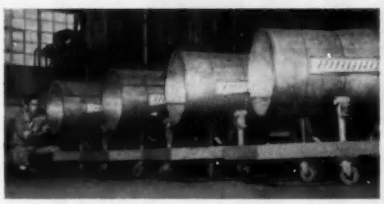


CLARK EQUIPMENT COMPANY • BUCHANAN • Battle Creek, Benton Harbor and Jackson, Michigan

RYAN
BUILDS THE HOT PARTS FOR JET ENGINES



The startling performance of America's great new fighters and bombers depends largely upon the knowledge and skill of the manufacturer of their jet engine components. These rugged "hot parts" must be built to jewel-like precision and exhibit amazing strength under extremely high temperatures.



Ryan Afterburners for Westinghouse J-46

Ryan is a pioneer in this field, developing the first American jet engine afterburner in connection with the Navy's first jet plane, also built by Ryan. Today, Ryan leads in the fabrication of sheet metal turbojet components and afterburners because of a unique combination of advantages: long experience in high temperature metallurgy — extensive know-how in forming, welding and machining heat-resistant alloys — the industry's most modern array of high precision machines. Few plants anywhere have the necessary equipment, methods and know-how for this specialized work.

With these facilities, Ryan is building afterburners and jet engine parts for General Electric, Westinghouse, Pratt and Whitney Aircraft, Wright Aeronautical and others. Ryan's $4 million worth of modern production tools produce high temperature jet engine components used in North American F-86 and F-100 Sabres, Boeing B-47 and B-52 Jet bombers, Convair F-102 fighters, Douglas F4D Skyray fighters and A3D attack bombers and McDonnell F-101 fighters. Currently, Ryan is building six different types of afterburners.

As the only maker of jet engine parts which also designs, builds and flies jet aircraft, Ryan is uniquely qualified for this exacting work. In virtually *every* field of aircraft development and production, Ryan is better prepared to solve the complex engineering and fabrication problems posed by the high speed air age.

RYAN

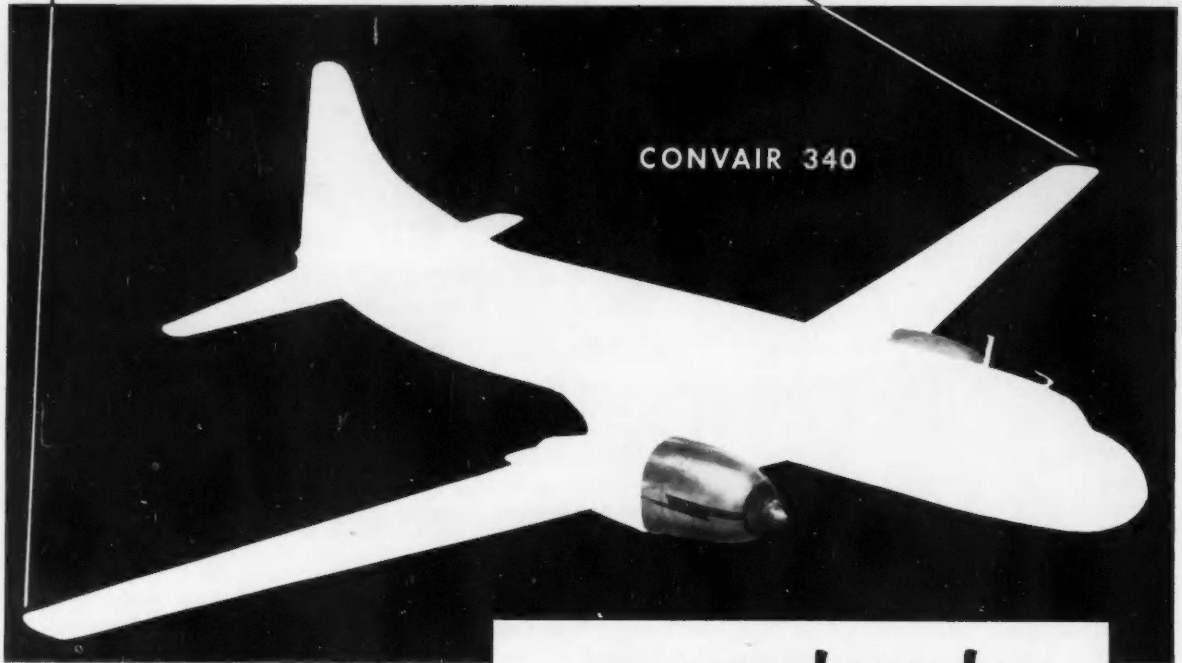
★ SPECIALIZED
★ INGENIOUS
★ VERSATILE

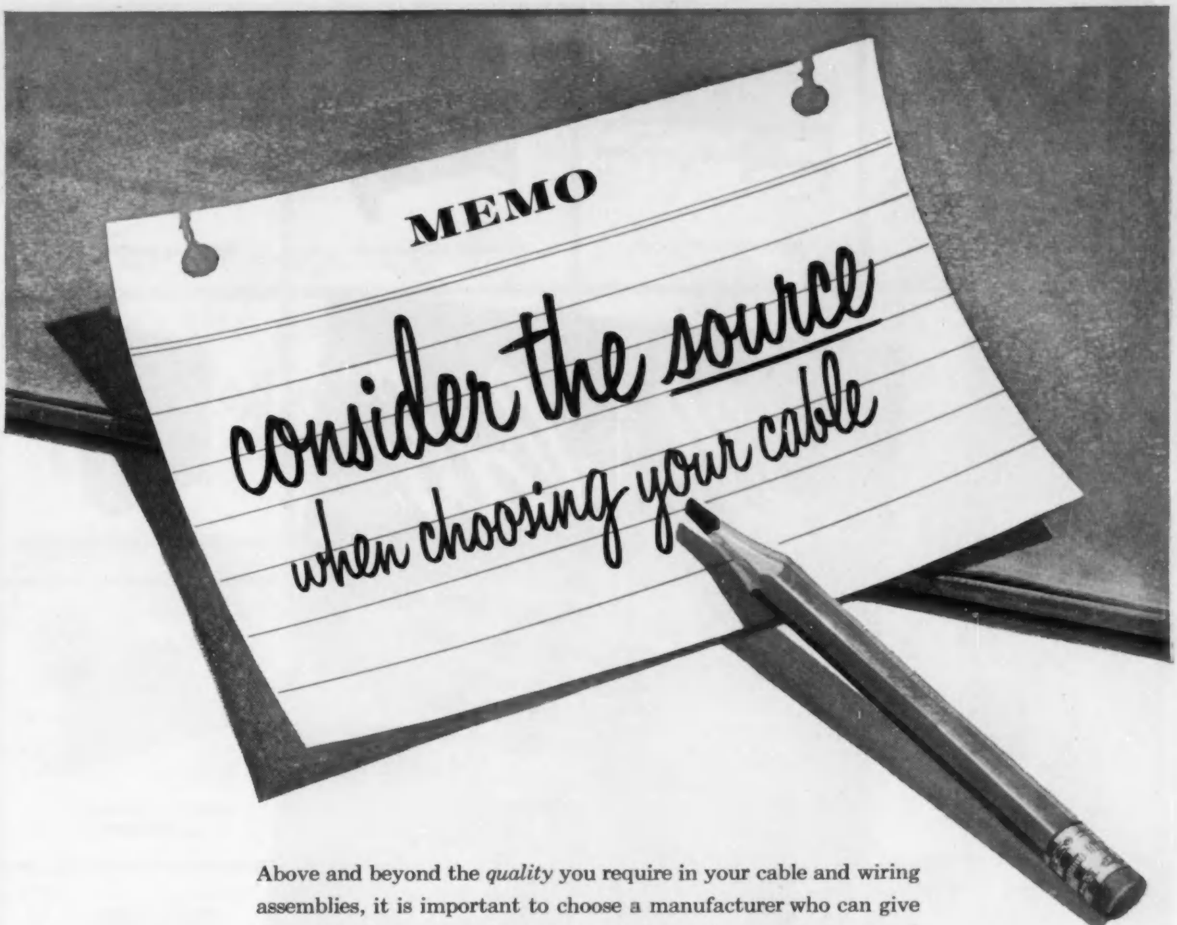
Advanced-type Aircraft and Components
Jet and Rocket Engines and Components
Exhaust Systems for Aircraft
Electronics Equipment
Ceramics for "Hot Parts"
Weapons Systems Design and Management
Aircraft and Power Plant Research
Metallurgical Engineering
Thin-Wall Ducting
Firebee Pilotless Jet Planes

Pioneers in Each . . . Leaders in All

RYAN AERONAUTICAL COMPANY

Factory and Home Offices, Lindbergh Field, San Diego 12, California
Other Offices: Washington, D.C.; Dayton, Ohio; Seattle, Washington; New York City


CONVAIR 340



Above and beyond the *quality* you require in your cable and wiring assemblies, it is important to choose a manufacturer who can give you such *plus advantages* as experienced engineering counsel and on-time delivery. Often it is intangibles such as these that help keep your production lines going.

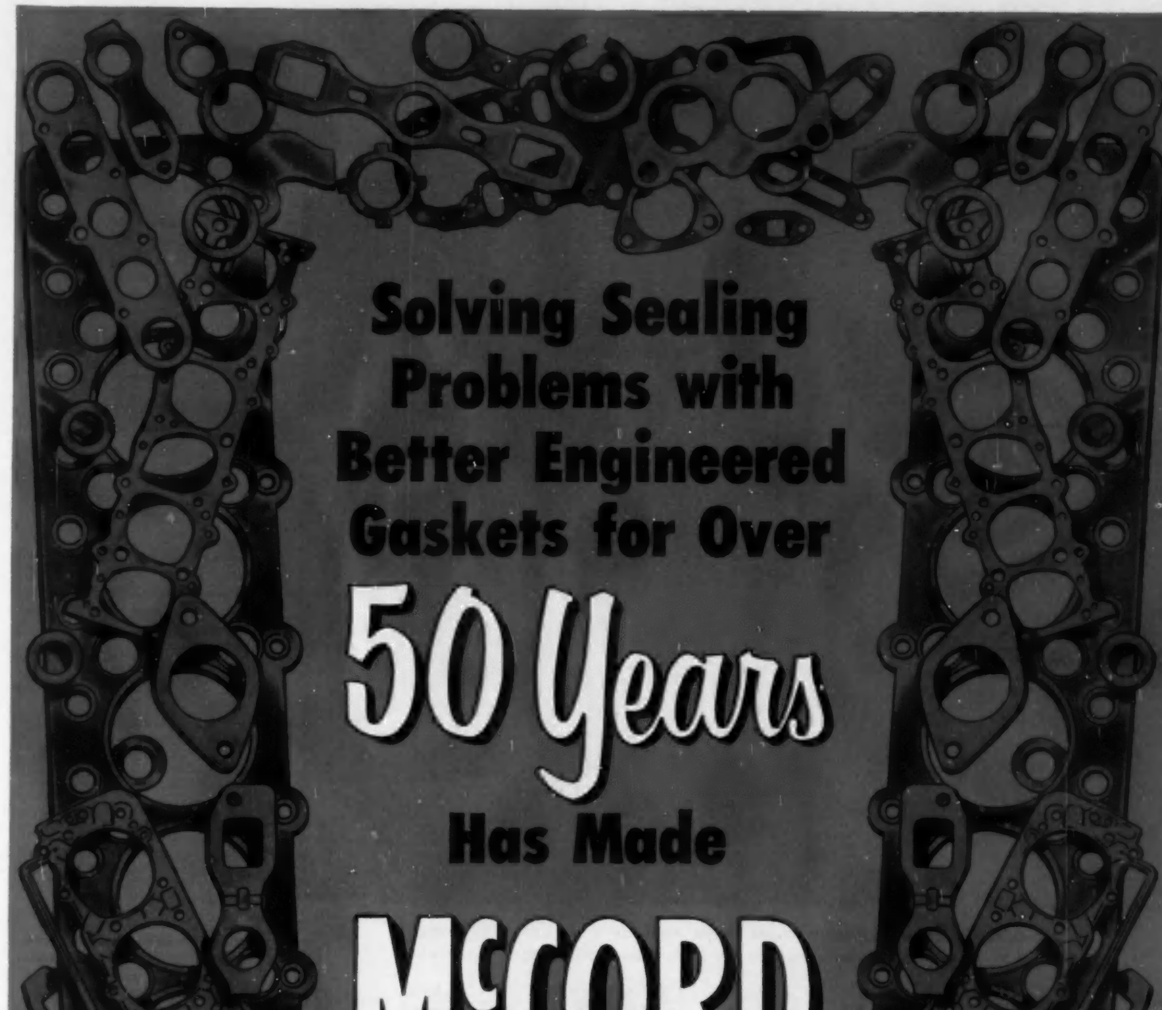
Consider Packard as a source

The wide use of Packard cable and wiring assemblies on America's foremost automotive vehicles, aircraft and appliances is your assurance of top quality. Packard's vast manufacturing capacity—more than 7,000,000 feet of finished cable and 800,000 wiring assemblies each day—is your assurance of regular delivery in any quantity you demand. And Packard's engineering ability assures cable and wiring assemblies correctly designed and fabricated to suit your requirements. These are factors that often result in worthwhile savings to Packard customers.

Packard
REG. U.S. PAT. OFF.
TRADE MARK

Packard Electric Division • General Motors Corporation • Warren, Ohio

AUTOMOTIVE, AVIATION AND APPLIANCE WIRING


Solving Sealing Problems with Better Engineered Gaskets for Over
50 Years
Has Made
McCORD
the GASKET HEADQUARTERS of the Industry
McCORD CORPORATION
Detroit 11, Michigan

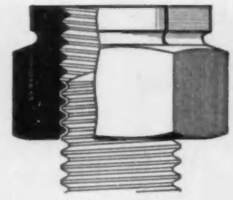
More and more automotive repair shops and industrial plants are turning to FLEXLOCs to reduce maintenance on high speed, vibrating equipment.

FLEXLOC locknuts save $600 per year in reconditioning automobile engines

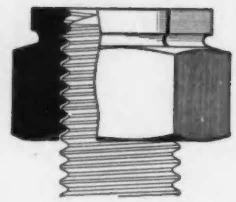
By using FLEXLOCs on connecting rod bolts, a motor reconditioning shop cut assembly time by a minimum of 5 minutes per motor. This added up to a yearly saving of 250 hours or $600. No drilling of bolts was needed . . . no adjusting of nuts to set cotter pins was required. And the FLEXLOCs assured a tighter assembly than was possible with the castellated nuts and cotter pins formerly used.

FLEXLOC locknuts reduce maintenance too. Once they are installed, you can forget them. Service and inspection periods can be stretched safely from days to weeks. And FLEXLOCs are reusable. They can be applied again and again without losing locking efficiency.

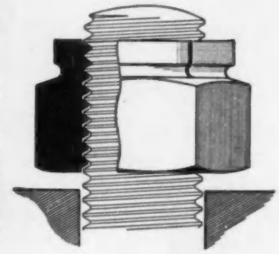
You can get FLEXLOC Self-Locking Nuts of various types and materials in a wide range of sizes and in any quantity. These one-piece, all-metal nuts are carried in stock by leading industrial distributors everywhere. Write for literature and samples for test purposes. STANDARD PRESSED STEEL Co., Jenkintown 55, Pa.



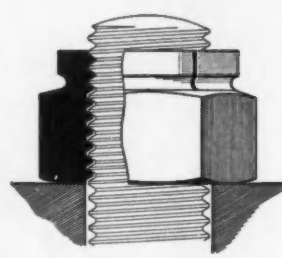
Starting. A FLEXLOC starts like any ordinary nut. Put it on with your fingers. Tighten it with a standard hand or speed wrench.



Beginning to Lock. As the bolt enters the segmented locking section, the section is expanded, and the nut starts to lock.



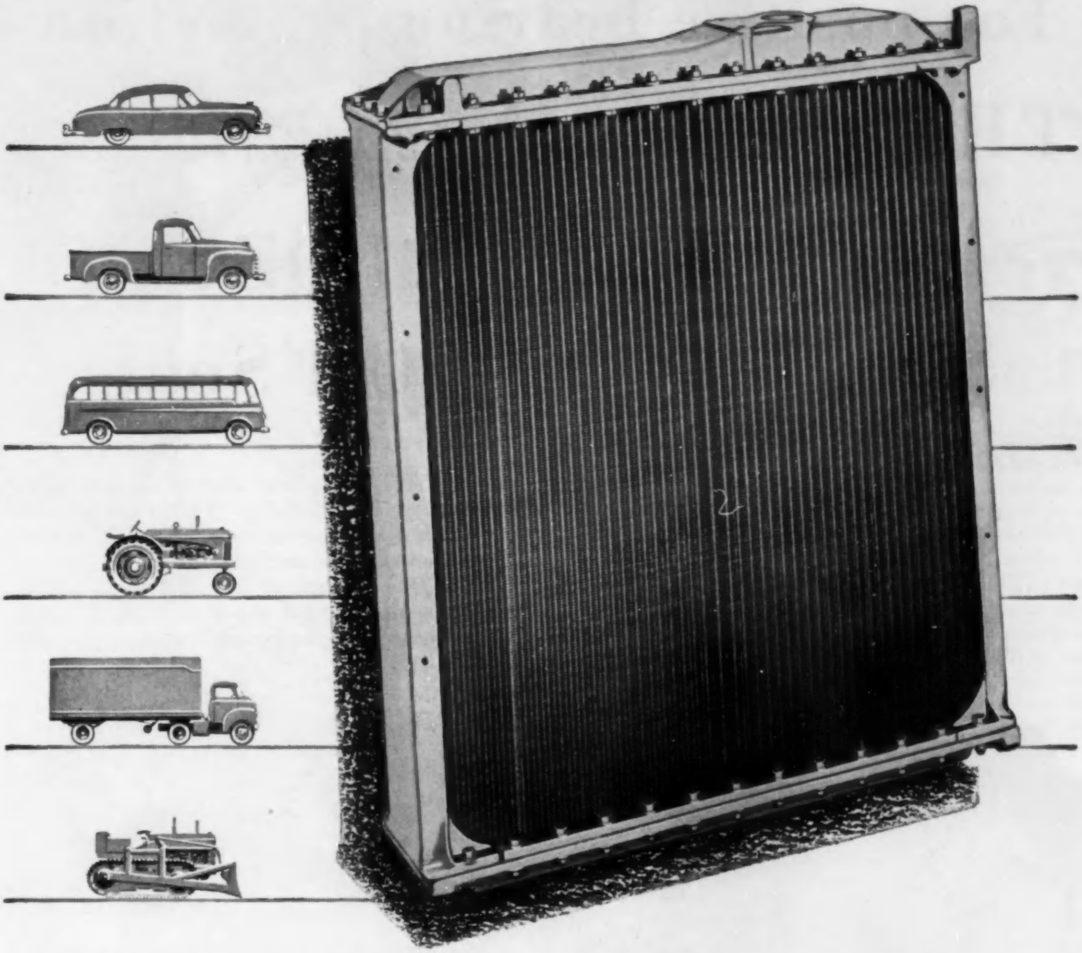
Fully Locked As a Stop Nut. When 1½ threads of a standard bolt are past the top of the nut, the FLEXLOC is fully locked. A FLEXLOC does not have to seat to lock.

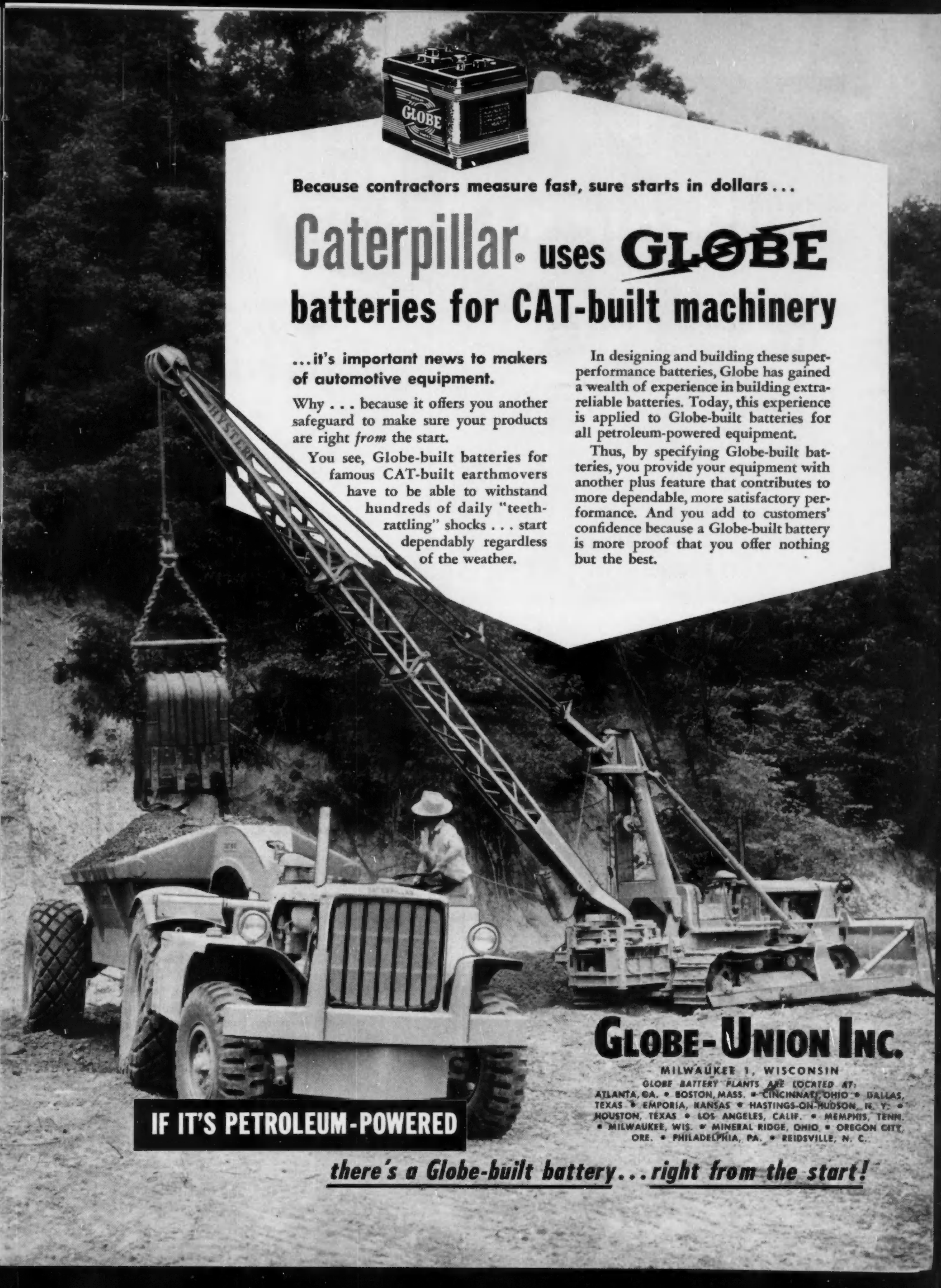


Fully Locked As a Seated Nut. When it is used as a lock or stop nut, the locking threads of the FLEXLOC press inward against the bolt, lifting the nut upward and causing the remaining threads to bear against the lower surface of the bolt threads. Vibration will not loosen a FLEXLOC, yet there is no galling of threads.

FLEXLOC® LOCKNUT DIVISION

SPS
JENKINTOWN PENNSYLVANIA





GLOBE
Because contractors measure fast, sure starts in dollars . . .
Caterpillar® uses GLOBE batteries for CAT-built machinery
. . . it's important news to makers of automotive equipment.
Why . . . because it offers you another safeguard to make sure your products are right *from* the start.
You see, Globe-built batteries for famous CAT-built earthmovers have to be able to withstand hundreds of daily "teeth-rattling" shocks . . . start dependably regardless of the weather.
In designing and building these super-performance batteries, Globe has gained a wealth of experience in building extra-reliable batteries. Today, this experience is applied to Globe-built batteries for all petroleum-powered equipment.
Thus, by specifying Globe-built batteries, you provide your equipment with another plus feature that contributes to more dependable, more satisfactory performance. And you add to customers' confidence because a Globe-built battery is more proof that you offer nothing but the best.
HYSTER
GLOBE-UNION INC.
MILWAUKEE 1, WISCONSIN
GLOBE BATTERY PLANTS ARE LOCATED AT: ATLANTA, GA. • BOSTON, MASS. • CINCINNATI, OHIO • DALLAS, TEXAS • EMPORIA, KANSAS • HASTINGS-ON-HUDSON, N. Y. • HOUSTON, TEXAS • LOS ANGELES, CALIF. • MEMPHIS, TENN. • MILWAUKEE, WIS. • MINERAL RIDGE, OHIO • OREGON CITY, ORE. • PHILADELPHIA, PA. • REIDSVILLE, N. C.
IF IT'S PETROLEUM-POWERED
there's a Globe-built battery . . . right from the start!

EXTRA STRENGTH WITHOUT EXTRA LENGTH

moraine-400

IS THE TOUGHEST AUTOMOTIVE ENGINE BEARING EVER DEVELOPED

The extraordinary toughness of Moraine-400 permits the use of shorter bearings . . . permits automotive engineers to step up engine horsepower without increasing engine size. Crankshafts can be *strengthened* without being *lengthened*—still carry greater piston loads! Space gained between bearings can be utilized for heavying-up crankarms. In short, with Moraine-400, bearing *length* ceases to be a limiting factor in engine design.

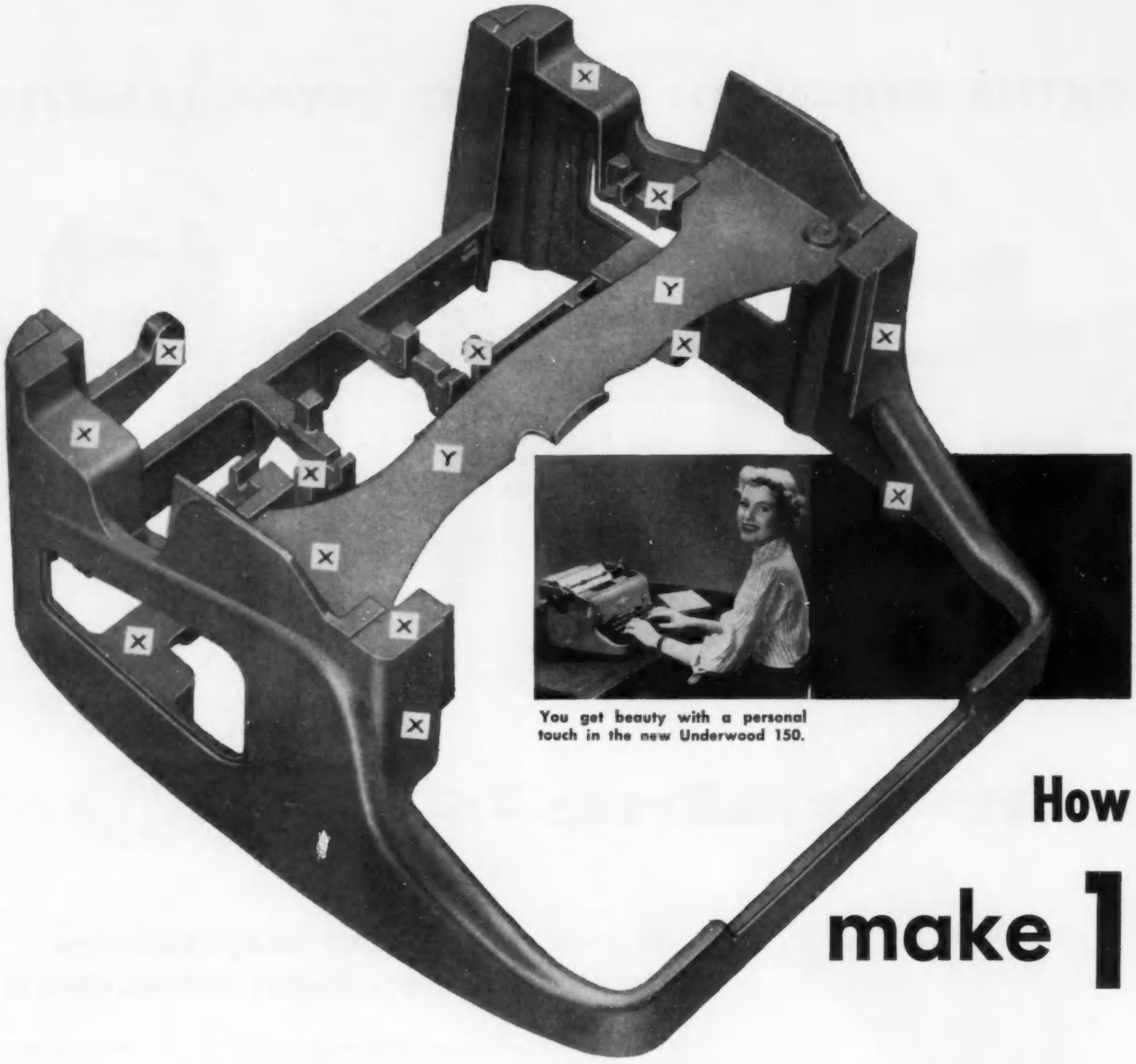
The extreme toughness of the Moraine-400 is due to a new bearing metal, developed by General Motors-Moraine research over a ten-year period. This aluminum-base alloy, bonded to a steel back, has amazing toughness. Moraine-400 bearings operate satisfactorily on oil-hardened and Tocco-hardened shafts, and are outstandingly good in such qualities as embedability, conformability, and resistance to corrosion.

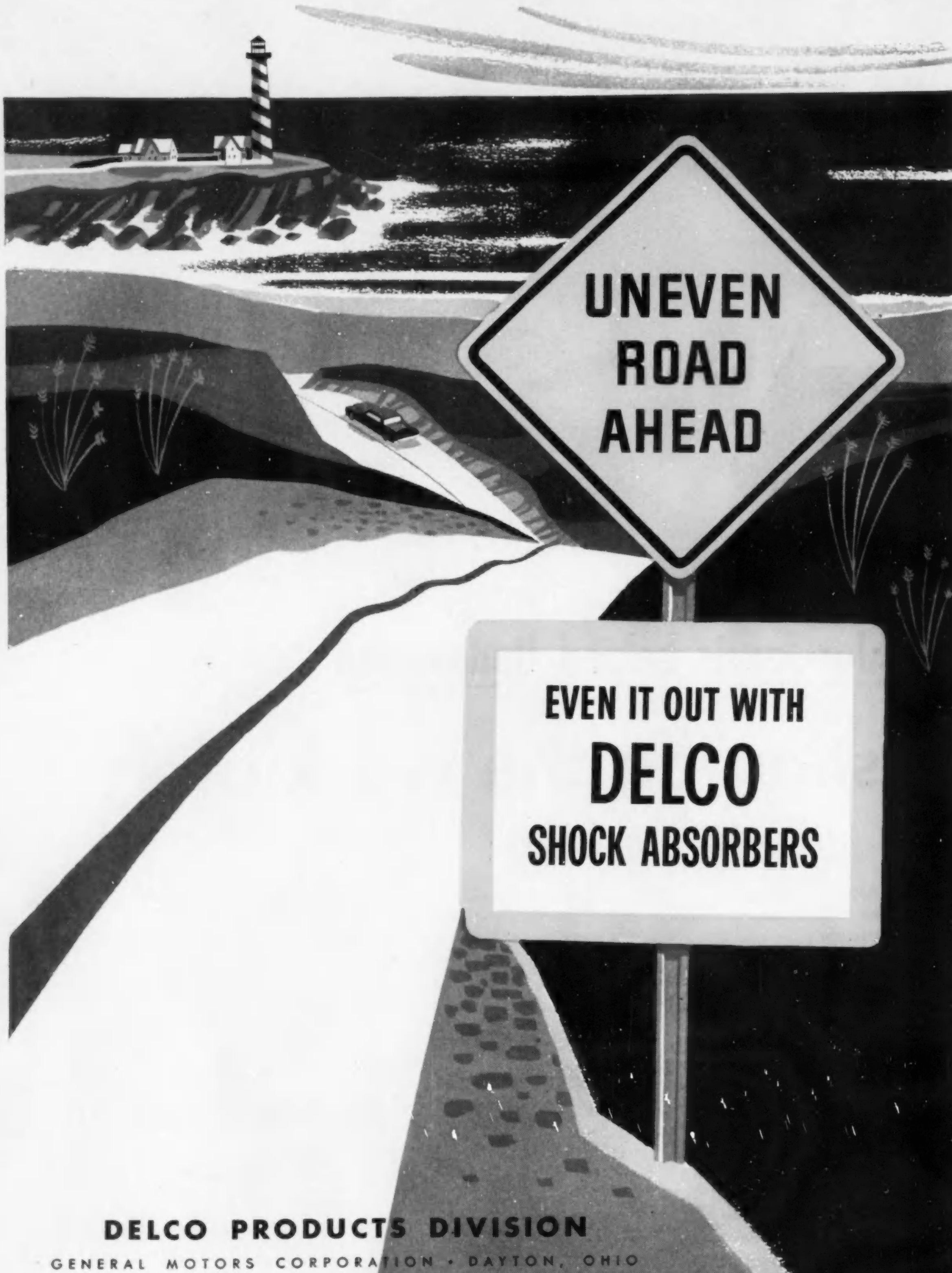
Note: Moraine also makes the famous Moraine-*100* bearings—now used as original equipment on many of the nation's finest cars and trucks.

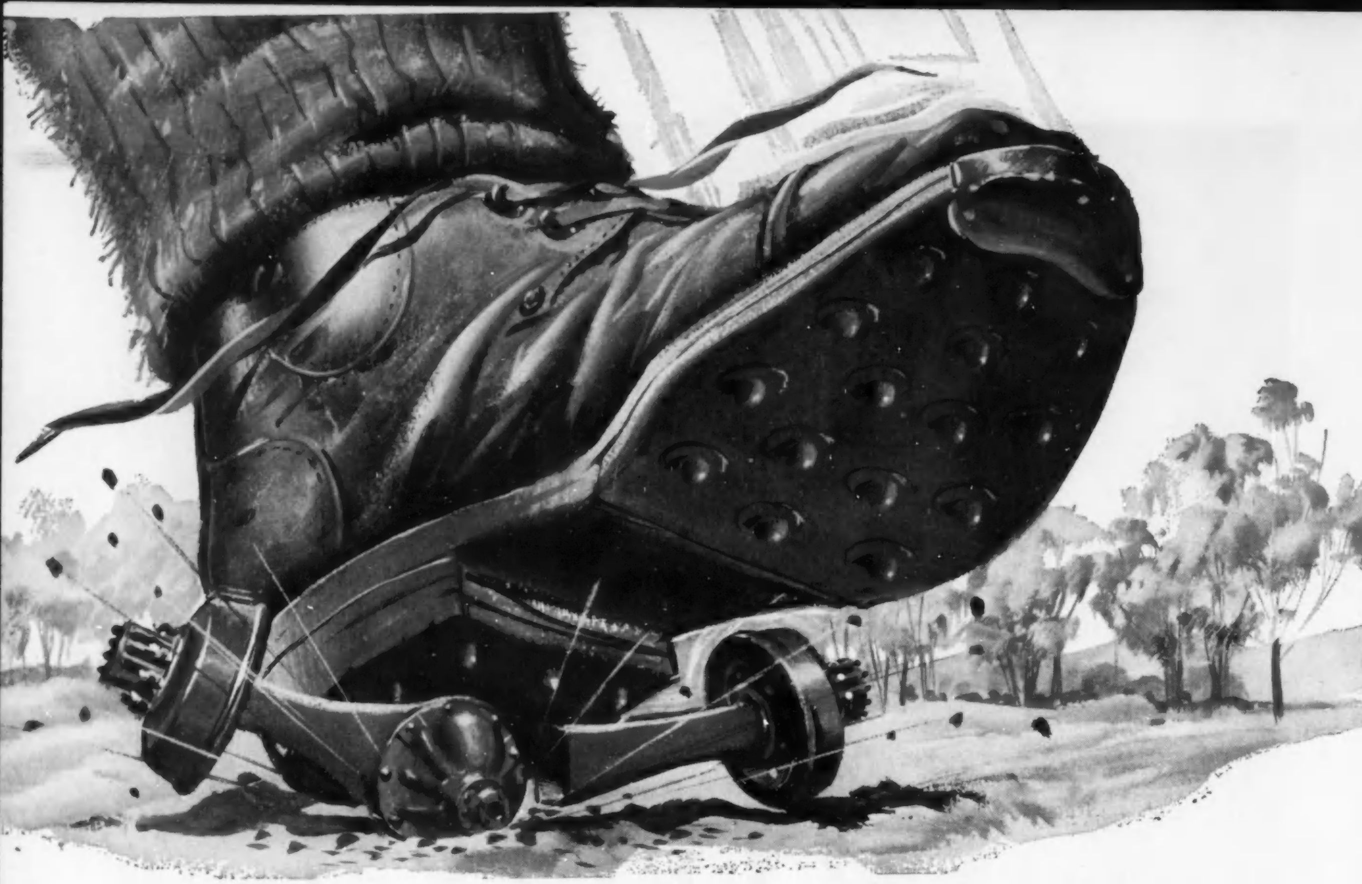
m

moraine products

DIVISION OF GENERAL MOTORS CORPORATION, DAYTON, OHIO




UNEVEN
ROAD
AHEAD
EVEN IT OUT WITH
DELCO
SHOCK ABSORBERS
DELCO PRODUCTS DIVISION
GENERAL MOTORS CORPORATION • DAYTON, OHIO



We grind truck axles to

in the new Timken-Detroit indoor proving ground . . . and only

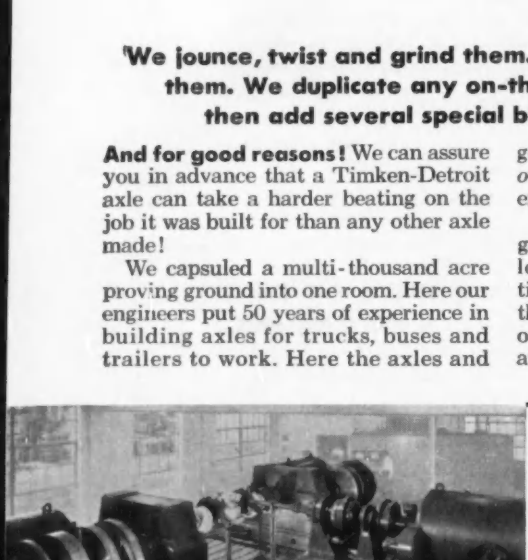
We jounce, twist and grind them. We abuse, torture and ruin them. We duplicate any on-the-job hauling situation... then add several special brutal tests of our own.

And for good reasons! We can assure you in advance that a Timken-Detroit axle can take a harder beating on the job it was built for than any other axle made!

We capsuled a multi-thousand acre proving ground into one room. Here our engineers put 50 years of experience in building axles for trucks, buses and trailers to work. Here the axles and gearing are subjected—*indoors*—to any *outdoor* hauling condition . . . and scientifically analyzed.

It's research to the "umpteenth" degree. But *you* enjoy: longer truck life; less maintenance, repairs and downtime; lower operating costs. That's why the smart money of truck builders and owners rides on Timken-Detroit axles and gearing.

Whatever he hauls . . . simulated service conditions show up electronically on a screen like this. For instance—a heavily loaded truck on a bumpy, twisting road—then on a level express highway or long grade. What happens to the axle and gearing is measured, charted with absolute scientific accuracy.



TDA proves axle quality and performance in this "Torture Chamber"

Here we simulate actual highway conditions . . . test quality and performance of axles under any hauling situation, such as duplicating the kinetic energy of 80,000 lbs., G.C.W., at 60 m.p.h. All tests are repeated hour after hour with an automatic cycling control.

He's hauling steel . . . he wants axles that can "tote" the load—on highway, side roads and open fields . . . can do it fast, powerfully, dependably. He wants axles that absorb punishment . . . are easy and cheap to maintain . . . stingy on repairs and downtime. He wants Timken-Detroit "Torture-Tested" axles with Hypoid gearing.

He's an intercity hauler . . . he wants axles with pulling power *plus* speed—under any conditions . . . without beating the engine to pieces. He wants economical, dependable performance and low upkeep . . . little downtime for repairs . . . long truck life. All these he can have in Timken-Detroit "Torture-Tested" axles with Hypoid gearing.

He delivers goods . . . he wants axles that will take him anywhere . . . stop and go. He wants power and speed where it counts . . . plus easy operation. He wants low maintenance and repair costs . . . little shoptime. He wants Timken-Detroit "Torture-Tested" axles with Hypoid gearing!

pieces

Timken has it!

TIMKEN Detroit AXLES

TIMKEN-DETROIT AXLE DIVISION
ROCKWELL SPRING AND AXLE COMPANY
DETROIT 32, MICHIGAN

The Accepted Standard — TRADE MARK REGISTERED

"TORTURE-TESTED"
to Save Money on the Job

WORLD'S LARGEST MANUFACTURERS OF AXLES FOR TRUCKS, BUSES AND TRAILERS

Next truck you design . . . figure on Timken-Detroit Hypoid gearing

Hypoid gearing for truck axles was pioneered by Timken-Detroit.

Proved in billions of ton-miles of actual operation. Designed to give the slower gear ratios necessary for modern engines without loss of strength. Pinion is bigger, stronger . . . bearings are larger . . . more teeth in contact reducing loading per unit of contact area. Torque transmitting capacity increased to step up performance and rugged power.

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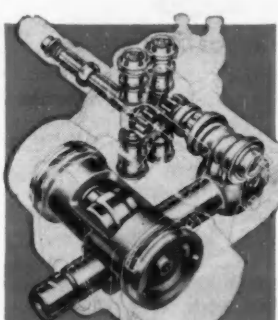

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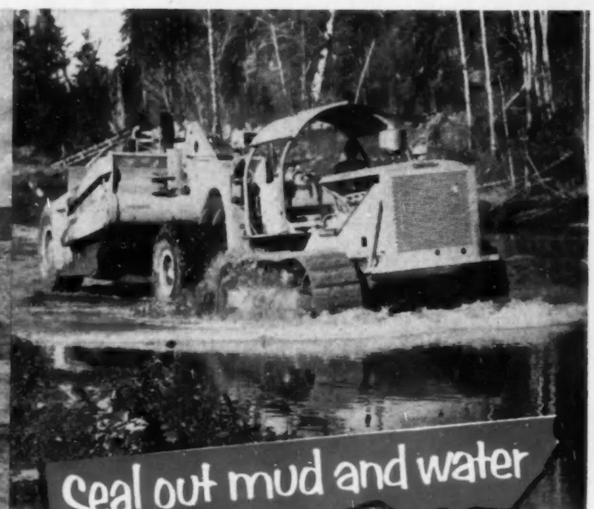

Installing a dust seal gasket between the castings in the bevel gear and steering clutch compartment of a Caterpillar track-type Tractor.

Probably tractors encounter more severe operating conditions than almost any other piece of mechanical equipment, and for that reason it is vitally important to keep dust, grit, and water out of operating parts, and oil and grease in. Felt seals are ideal for this purpose, and American is proud to supply felt for sealing to Caterpillar Tractor Co., Peoria, Illinois. In these days of expanding construction, you will see Caterpillar-built machinery everywhere. Felt is in many of them, unseen, helping protect performance, reliability, and long life . . . American makes various types of felt for sealing purposes, and supplies it as desired, including gaskets and washers cut to size. For information, write for Data Sheet No. 11, "Felt Seals, Their Design and Application."

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